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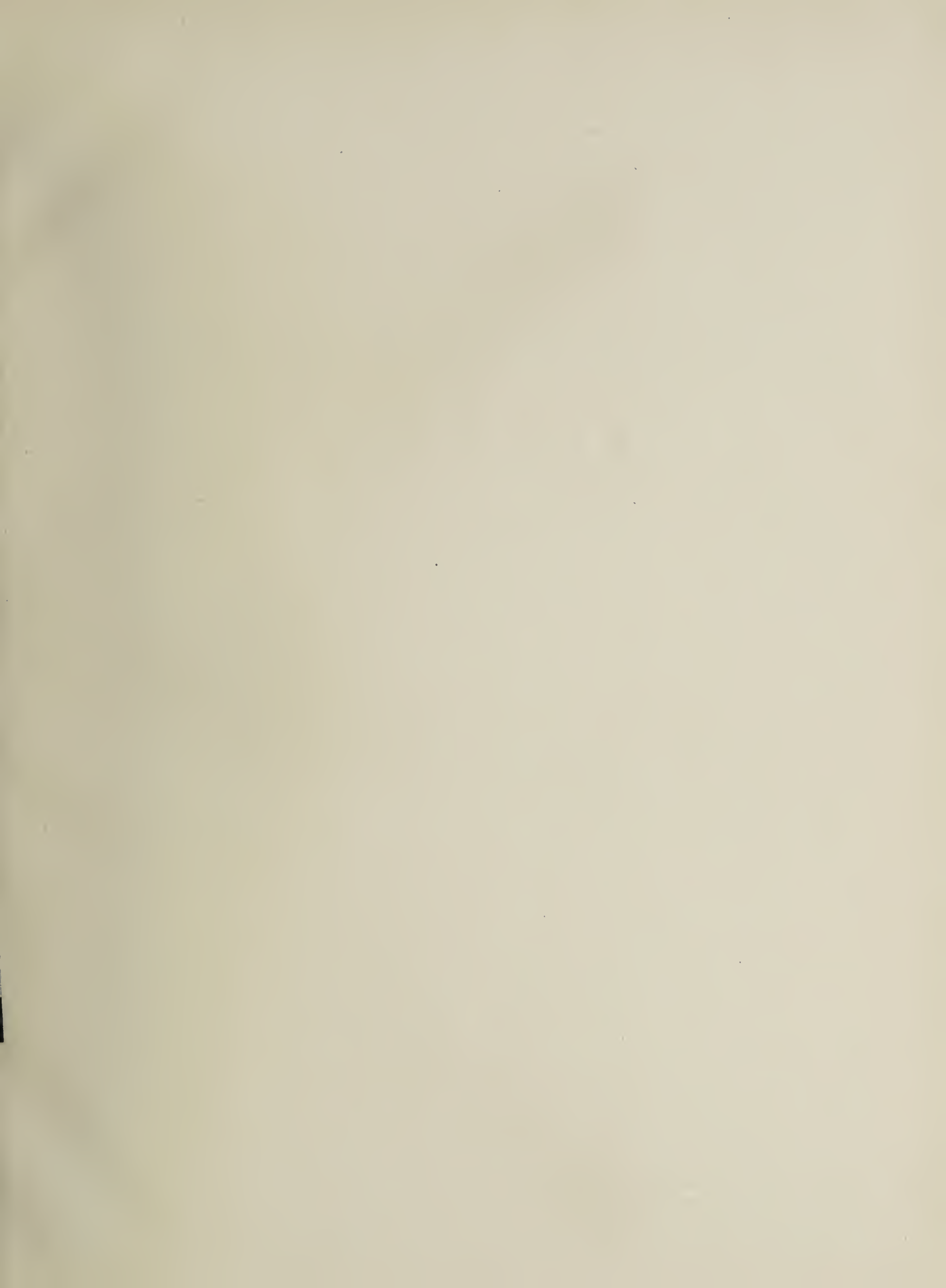
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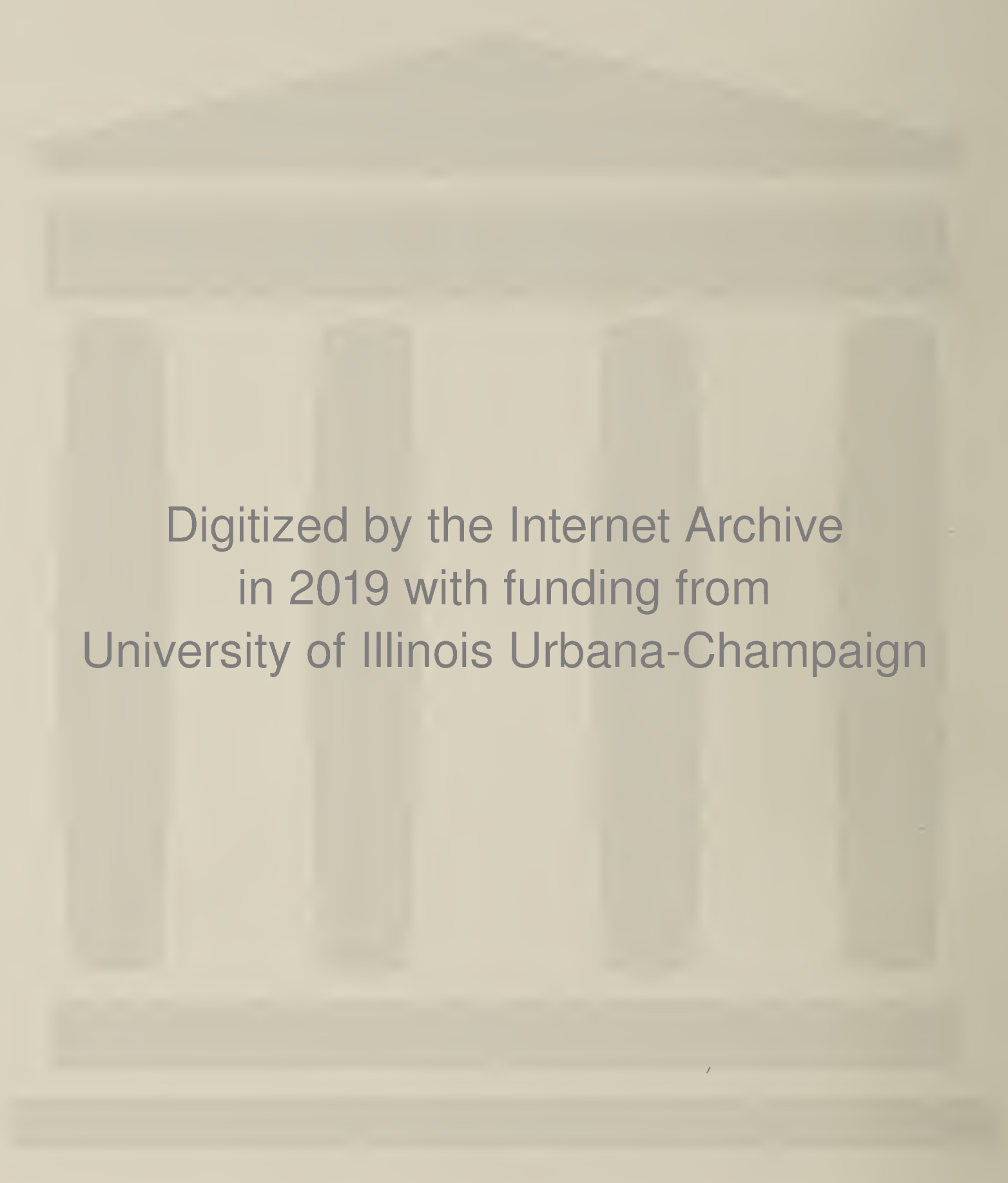
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Vol. 23. January—December, 1911

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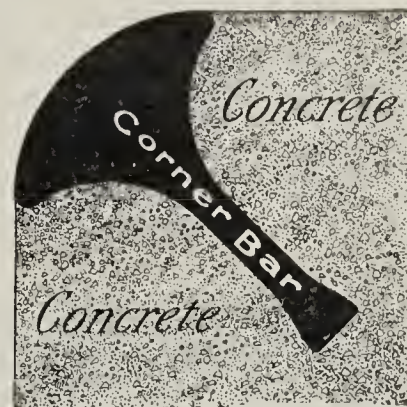
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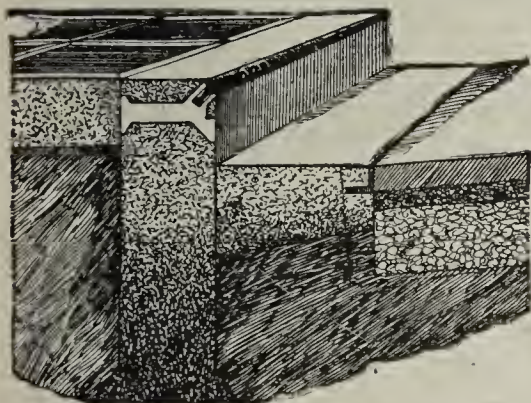
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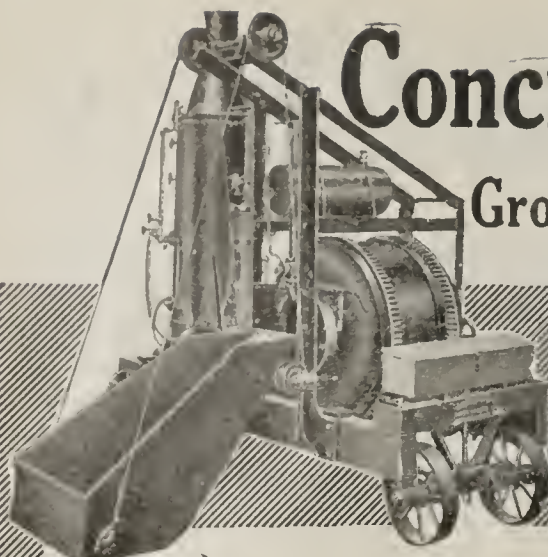
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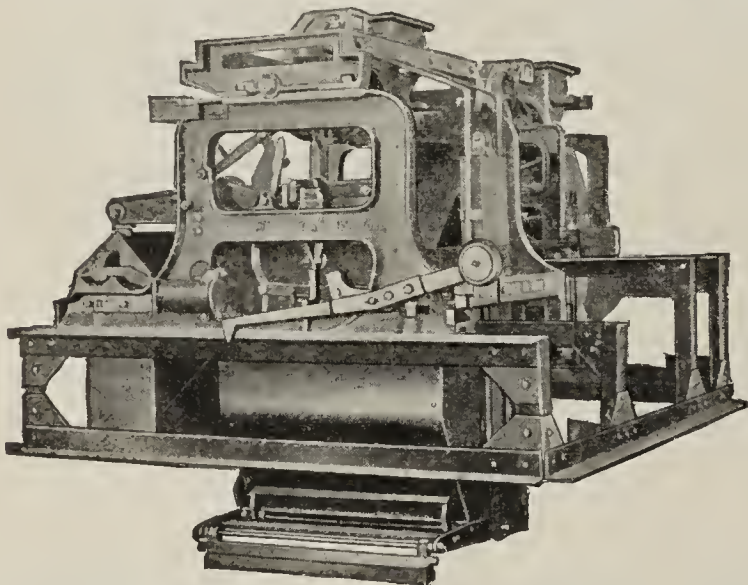
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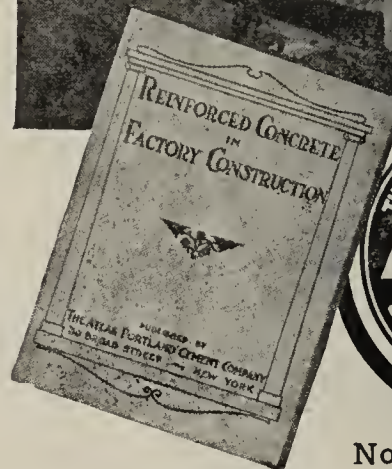
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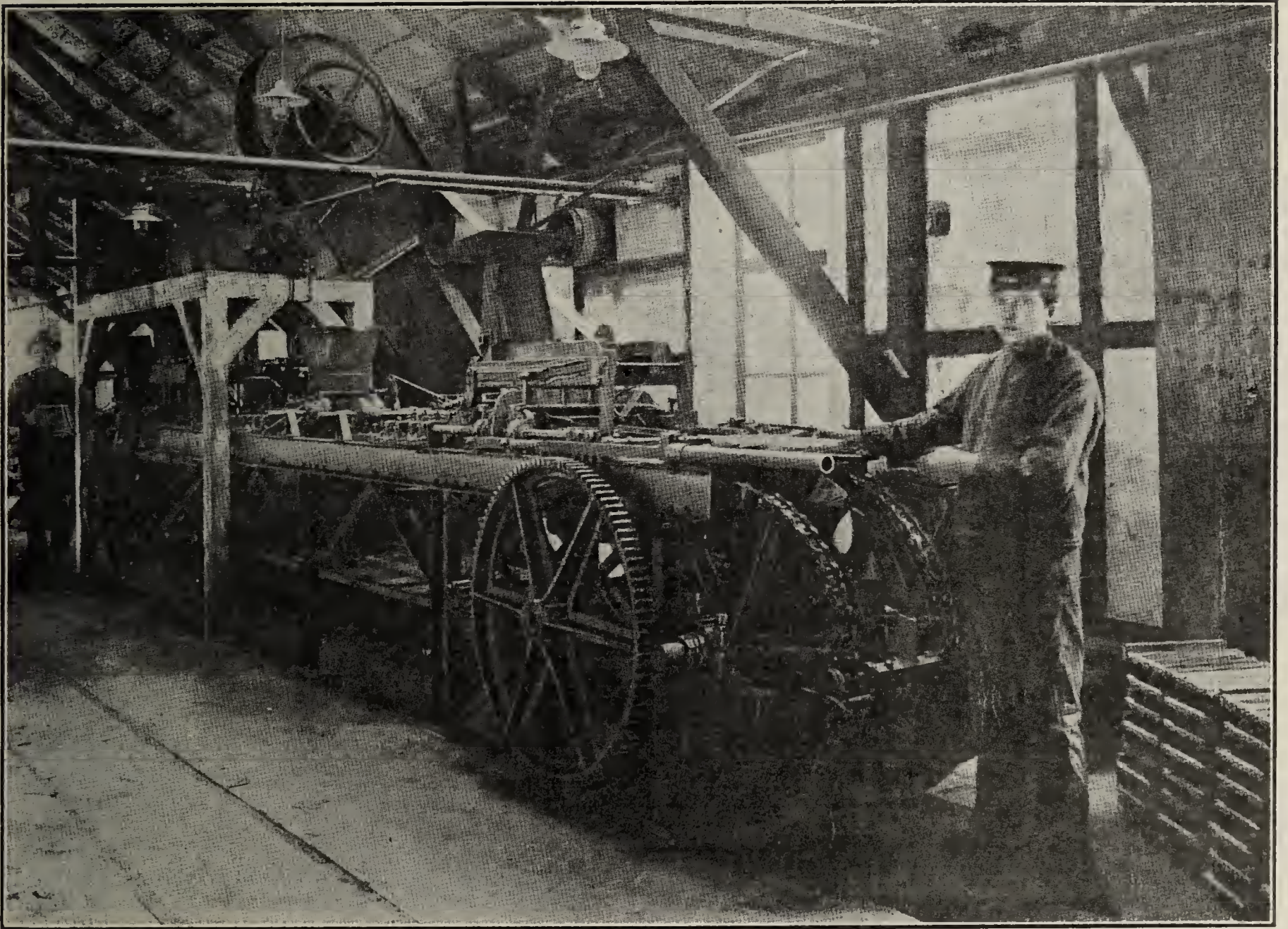
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CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

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Chicago, January 1911.

THE LATEST RESEARCHES ON CEMENT.

While up to a short time ago the efforts of most experimenters were bent upon explaining the composition of Portland cement in the calcined state, the researches of the past two or three years aimed principally at the hardening process.

The outcome of these modern researches has been a complete verification of Michaelis' colloid theory, according to which the hardening of cements and their resistance to water is brought about in the first place by colloidal bodies, while the process of crystallization to be observed in hardening cements is of minor importance.

About a year ago, Becker explained (see Cement and Engineering News, February, 1910; page 47) why experimenters mostly overlooked the colloidal bodies forming upon hydration of cement and why most of them did not report anything but crystallized products, namely because they gauged the cement with an excess of water, thus favoring crystallization, whereas all cements stirred with as little water as used in practice showed mainly colloidal bodies and only a limited amount of crystals.

During the last years, a great number of experimenters convinced themselves of the correctness of the colloid theory, so that the old-time theory, according to which the hardening process of cements was considered to be a pure process of crystallization on the order of gypsum, has been definitely abandoned. Among the latest advocates of the colloid theory are Rohland, Ambronn, Becker and Keisermann.

The research work of the last-named experimenter is published on the following pages. His researches are an absolute deviation from former methods in as much as he introduces a novel method of staining the microscopic preparations, which enables him to distinguish the chemical nature of the colloidal bodies and crystals forming during the process of hydration. The paper describing his experiments, therefore, contains many points of interest.

Keisermann's staining process undoubtedly will be of service to chemists carrying on similar researches and will be considered an important step towards the final solution of the problem. However, it remains to be seen how far the conclusions drawn by the author apply to the hardening of commercial cement. Did he use an excess of water for his microscopic preparations, as many investigators before him, and was he right in using fused cements for his experiments instead of merely sintered products?—The answer to this question will finally be given by experimenters who will continue the work along the same lines.

THE HARDENING AND CONSTITUTION OF PORTLAND CEMENT.

By S. Keiserman.

(With criticism by Dr. W. Michaelis, Sr.)

INTRODUCTION:

According to the definition of the Association of German Portland Cement Manufacturers, Portland cement is "a hydraulic cement of a specific gravity not less than 3, determined in the calcined state, containing not less than 1.7 parts by weight of calcium oxide to one part by weight of silica, alumina and iron oxide combined, and produced by calcination to a point of vitrification of an intimate mixture of the raw materials and subsequent grinding to an impalpable powder."

This definition was necessary in order to distinguish Portland cement from other hydraulic cements, for example, from Roman or natural cement, obtained by calcination of argillaceous limestone at a temperature below the sintering point, and from natural volcanic products or puzzuolanas (as, for instance, puzzuolana proper, santorin earth and trass), which yield a hydraulic cement, if mixed with slaked lime, furthermore, from artificial puzzuolanas, produced by granulation of blast furnace slag, from waste products in the manufacture of alum and from glass.

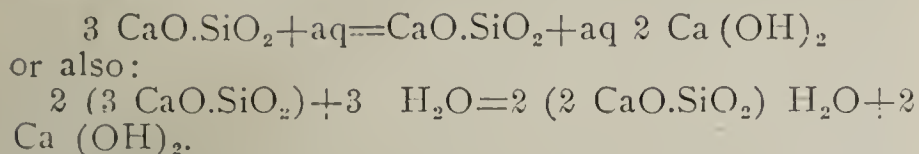
Numerous assays have been written on the hardening and constitution of Portland cement and about 28 theories have been advanced, the most prominent of which I shall discuss in the following: They embrace three fundamentally different views on the constitution and hardening of cement.

Several experimenters, as Fuchs, Pettenkofer, Erdmenger, Rohland and others, assume cement clinker to be a mechanical mixture of lime, soluble silica and clay and believe that, upon addition of water, the silica combines with the so far uncombined lime to calcium silicate.

The second opinion is that, in the burning process, a compound of calcium oxide and silica is formed, not higher in lime than the di-calcium silicate, and that part of the lime contained in Portland cement is not chemically combined. According to this theory, mono-calcium-silicate and calcium hydroxide are formed upon hydration; the latter is gradually converted into calcium carbonate. This view is shared by Berthier, Rivot and Chatonier, Feichtinger, Zulkowsky, Heldt, Fremy, Oddo, Hart, Loebell and others, who made special efforts to determine the free lime. Thus, Zulkowsky attempted to extract the uncombined calcium oxide with an alcoholic solution of potassium nitrate and Hart with potassium iodide in alcohol; the latter found 30% of uncombined lime. By means of various other methods Loebell estimated it to be from 10% to 26%. However, all these methods of investigation were open to criticism. Jordis and Kanter demonstrated that all calcium silicates and calcium aluminates were decomposed by solutions of salts in water or alcohol and that free calcium hydroxide was formed. From this observation they made the deduction that it was impossible to determine free calcium oxide in cement by means of liquids. Ostwald and Blank tried to solve the problem in a different way and succeeded, by thermochemical determinations, in making the presence of free lime in cement very probable.

The third view on the subject, taken by Winkler, Michaelis, Le Chatelier, Toernebohm, Rebuffat and others, is that, in the burning, all lime goes into combination and that tri-calcium silicate and tri-calcium aluminate are formed. The process of hydration is

assumed to take place according to the following formula:



In order to prove this theory, a number of investigators tried to produce tri-calcium silicate by synthesis. Le Chatelier, for instance, fused the previously estimated amounts of calcium oxide and silica, but invariably obtained a mixture of silicate and free lime; the presence of the latter was revealed by strong development of heat immediately upon mixing with water. Also other methods, for example, admixtures of fluxes, did not enable him to obtain a homogeneous body. Newberry and Smith obtained, by fusion in an oxy-hydrogen flame of the proper amounts of calcium carbonate and quartz-powder, a crystalline product, which hardened well upon being mixed with water. Schmidt and Unger had the same experience. Schott fused calcium carbonate and silica in various proportions. The fused products of the composition $\text{CaO} \cdot \text{SiO}_2$ and $1.5 \text{ CaO} \cdot \text{SiO}_2$ remained intact upon cooling, while all higher-limed silicates partly disintegrated. The finely powdered fused products, of which he used only the non-disintegrated, solid portion, were mixed with three parts by weight of sand and made into briquettes, which showed the following tensile strength after 28 days:

2 $\text{CaO} \cdot \text{SiO}_2$	150 lbs. per sq. in.
2.5 $\text{CaO} \cdot \text{SiO}_2$	390 " " " "
3 $\text{CaO} \cdot \text{SiO}_2$	none

The last figure is in opposition to the results of former investigators who obtained well-hardening tri-calcium silicates.

Finally, Day and Shephard decided the question of the possible chemical compounds between calcium oxide and silica in an exact manner. They determined at first the melting points of a great number of mixtures of calcium oxide and silica and drew, with the aid of the figures thus obtained, the curve of the melting points of the lime-silica series. The curve plainly revealed the existence of two compounds containing 48% and 65% of calcium oxide, answering the mono-calcium silicate and di-calcium silicate. Furthermore, they succeeded in establishing, by optical methods, the non-existence of a tri-calcium silicate. Fused products containing more than 68% of calcium oxide, which were expected to contain tri-calcium silicate, were never found to contain the latter, but invariably di-calcium silicate and free lime. Attempts at obtaining a tri-calcium silicate by means of fluxes were equally unsuccessful; the resulting product was always a di-calcium silicate. Also Day and Shephard made the same observation as Schott and others, namely that fused products higher in lime than $1.5 \text{ CaO} \cdot \text{SiO}_2$ disintegrated into a solid portion and a powder. They explained the disintegration of the di-calcium silicate by the existence of three polymorphous modifications α , β and γ , which possessed characteristic optic properties. The α -modification is formed below the melting point at 1400—1410 centigrade and converts into the β - and γ -formation upon cooling; if cooled very rapidly, part of the α -modification remains stable.

While the experimenters so far mentioned paid their principal attention to the chemical composition of cement clinker, Michaelis carried on extensive researches with a view to determine the processes of hydration and hardening. He pointed out that colloidal silica, if mixed with calcium hydroxide, in the

presence of water, yielded a jelly of calcium-hydro-silicate at ordinary temperatures and that the same colloidal compound formed likewise in cement and is the cause of the hardening. Later he added that crystallization, if such a process should ever be observed in hardening cements, could not contribute to the hardening, but that, on the contrary, it would be rather harmful. This same view was repeated by him in his latest publications.

A new era began in the investigation of cements when microscopic researches were added to the former methods of examination. In this respect the work of Le Chatelier and Toernebohm deserve special mention. Both arrived, independently, at about the same conclusion with regard to the constitution of Portland cement. They found in microscopic sections of cement clinker four different kinds of crystals and, in addition, an amorphous mass. Toernebohm termed the crystals alite, belite, celite and felite.

Alite they considered to be the most important constituent, as it formed the main part of the clinker. It was made up of colorless crystals of feeble double refraction, partly of square and partly of hexagonal shape, and was more easily decomposed by water than the remaining crystals. Dilute acetic acid decomposed it readily, as all other crystals. Le Chatelier assumed alite to be a tri-calcium silicate containing certain impurities; he arrived at this conclusion through researches on clinker of low contents of iron and alumina, which latter occurred in the so-called "grappiers". Their composition corresponded approximately with the tri-calcium silicate; moreover, microscopic sections showed them to be composed almost entirely of alite crystals. Toernebohm, without further proving his assumption by experiments, attributed to alite the formula: $(3 \text{ CaO} \cdot \text{SiO}_2) + 9 \text{ CaO} \cdot 2 \text{ Al}_2 \text{ O}_3$.

Belite, occurring seldom in cement, forms blue-green crystals, of strong double-refraction similar to alite. It is found more frequently in clinker low in lime than in high-limed cements. Le Chatelier considers belite to be di-calcium silicate, whereas Toernebohm gives it the formula: $(2 \text{ CaO} \cdot \text{SiO}_2) + 3 \text{ CaOAl}_2 \text{ O}_3$. However, both experimenters fail to prove the correctness of these statements.

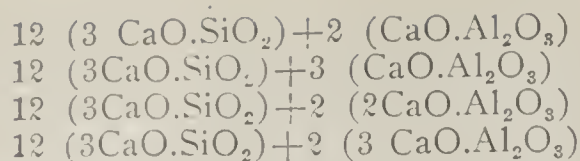
Celite is somewhat darker than belite and fills, as a rule, the voids between the other crystals. It shows no distinct crystallization; it is double-refracting. As celite occurs most abundantly in cements rich in iron and as, furthermore, it is of a yellow color, Le Chatelier believes its main constituent to be iron. He proves, furthermore, that the iron is contained in it as iron oxide. Toernebohm writes for celite the formula, $3 \text{ CaO} \cdot (\text{Fe} \cdot \text{Al})_2 \text{ O}_3 \cdot \text{SiO}_2$ without proving it, however.

Felite forms very small colorless double-refracting crystals which resemble belite as far as its optic properties are concerned. In many instances it is entirely missing in the clinker, especially if a large amount of belite is present. Toernebohm considers it to be identical with belite.

The glassy amorphous mass, about the composition of which none of the investigators reports anything, is isotrope and is strongly light-refracting. It is never contained in well-burnt clinker.

As mentioned, alite is to be considered the main constituent of Portland cement. Many investigators, therefore, were determined to produce it artificially. Of the numerous attempts in this direction three may be mentioned briefly:

Richardson burnt cement from calcium oxide, silica and alumina in the following proportions:



Microscopic examination of sections of these clinkers showed that the first contained, in addition to alite, a large amount of celite. With an increase of lime in the composition of the clinker, the contents of celite decreased. Richardson drew from this the conclusion that alite represented a solid solution of tri-calcium silicate in tri-calcium aluminate.

Schmidt and Unger confirmed these tests. They obtained alite, partly adulterated with celite, by gradually increasing the percentage of lime in the mixtures they subjected to fusion. In order to clear up the part taken by the alumina in the alite, they tried to replace it by other sesqui-oxides, especially by chromium oxide. They fused a mixture of 69% of calcium oxide, 6.5% of chromium oxide and 24.5% of silica and obtained a fused product that disintegrated partly upon cooling. A microscopic section of the uniformly green-colored solid part showed plate-crystals. The cement hardened with water very well, but slowly, and attained high strength under water. The experimenters, therefore, believed this product to be a chromium alite.

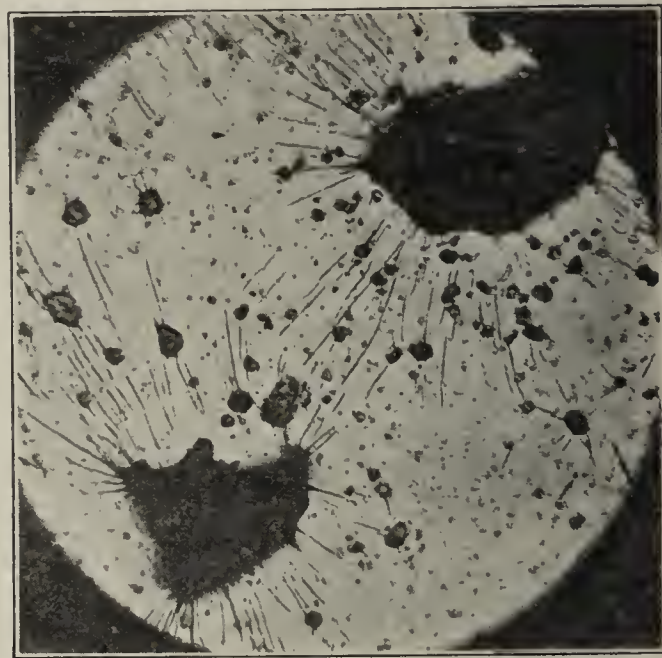
Mayer tried to replace the alumina by iron oxide and thus hoped to obtain an iron alite. However, microscopic sections of the clinker revealed colorless alite crystals which were, most likely, free of iron. The cement resulting from this clinker hardened well, which Le Chatelier had likewise observed in the case of other iron cements.

These different kinds of crystals could be observed only at clinker burnt to beginning vitrification. Fused cements, however, showed an entirely different picture under the microscope. Schott, for instance, found only needle-crystals, but no alite, celite or other crystals.

The microscopic examination has also been extended with success upon the study of the process of hydration and hardening of cement by Le Chatelier and Ambrohn. Le Chatelier followed the process of hydration with the microscope by allowing lime-water to act upon a thin section of cement clinker. After two or three days, hexagonal crystals and a fibrous crystalline mass formed. In several instances, he observed the formation of minute needle-crystals about 0.01 mm. long, which, most likely, formed the fibrous mass by interlacing. Ammonium salts destroyed the needle-crystals. Le Chatelier gave them the formula $\text{CaOSiO}_2 + 2.5 \text{ H}_2\text{O}$. Furthermore, he detected at a number of places small sphaerulites that showed a black cross in polarized light; these he took for $4 \text{ CaO} \cdot \text{Al}_2\text{O}_3 + 12 \text{ H}_2\text{O}$, a combination which he prepared artificially by the wet process.

Further experiments were conducted by him on hardened cements. For this purpose, he made use of a hardened cement briquette that had been kept under water for several months. Even a superficial examination with a magnifying glass enabled him to discern small hexagonal crystals on the surface of the briquette, which could easily be taken off. These crystals were likewise formed, if the cement hardened in the air. The angle of the hexagonal crystals was 60 degrees. Chemical analysis proved them to be composed of calcium hydrate slightly adulterated with silica. The existence of adulterations he explained by the fact that the hydrating lime contained foreign bodies mixed with it. The crystals grew steadily in consequence of continuous precipitation of calcium hydrate on their surface.

Microscopic sections of the briquette revealed the same hexagonal crystals imbedded in a white opalescent mass which did not act upon polarized light. He took this hyaline mass for a conglomeration of many of the small crystals observed in the previous preparation and explained the fact, that it was optically isotrope, by a similar stratification of the crystals as in the case of gypsum. (Gypsum, upon hydrating, crystallizes in plainly visible double-refracting crystals; a microscopic section, however, proves it to be isotrope, because a great number of crystals are lying in all directions one on the top of another.) The microscope, furthermore, showed brown almost unchanged particles of clinker, which contained iron oxide.



Crains of Portland cement in the earliest stage of hydration. The preparation was allowed to dry out, whereby needle-crystals of calcium hydrate developed, which showed that the water was soon transformed into a saturated solution of calcium hydrate.

Ambrohn studied the hardening process under the microscope in a somewhat different way. He mixed a small amount of powdered clinker with water on the microscopic slide and observed, in the course of the first days, that the grains of clinker were covered with a great number of needle- and plate-crystals. The needle-crystals were very thin, so that their diameter could hardly be determined with the aid of the microscope, and could be seen only with difficulty under normal conditions. The needle-crystals radiating from neighboring grains of clinker were interlaced and thereby, most probably, caused the grains to firmly adhere one to another. Ambrohn regarded this as the beginning of the hardening process. The plate-crystals stood mostly on edge, and, therefore, appeared as thick short needle-crystals. As the plate-crystals, in the same way as the fine needle-crystals, radiated from the cement grains and as those going out from adjoining grains interlaced, he considered it possible that they contributed also to the cementing together of the clinker grains. In addition to the former two kinds of crystals, he observed, after several days, a third belonging to the hexagonal system and considerably surpassing the former in size. They obtained sometimes a diameter of 0.5 mm. The same shape of crystals was likewise observed by him, as by Le Chatelier, on the surface of the hardened cement. Finally, he noticed a colloidal mass form around the various kinds of crystals which greatly assisted the process of cementation. The essential part of the final hardening process was, in his opinion, the gradual incrustation of this colloidal mass with

submicroscopic deposits of lime- and silica-compounds, whereas the formation of crystals, especially that of the minute needles and hexagonal plates played an important part in the setting of cement.

The research work carried on so far, principally the microscopic investigations, have established the fact that hardened cements contain, in addition to a colloidal substance, hydrated chemical compounds, in form of crystals and that the clinker likewise contains crystallized compounds. However, it remained uncertain what compounds formed in both instances. The solution of this question was the aim of the following researches, in which the attempt was made to determine at first the nature of the bodies formed during the process of hydration and, in the second place, to draw conclusions from these with regard to the composition of the crystals occurring in the clinker and hence to the constitution of cement.

I. CHEMICAL BODIES FORMING DURING THE HYDRATION OF CEMENT.

A. Methods of Investigation:

From his research work Ambronn had gained the experience, that the customary macro-chemical methods of investigation did not enable the experimenter to draw definite conclusions about the chemical nature of the bodies formed during the hydration of cement, and therefore concluded his publication with the remark that, most likely, extensive micro-chemical investigations would be more apt to lead to a solution of the problem. Following this advice, micro-chemical methods of investigation have been used exclusively during the researches described hereafter:

For microscopical examination the finely powdered substance was stirred on the object slide with as little water as possible and then protected with a cover glass. The preparations were prevented from drying out by either keeping them in a moist chamber or by sealing the cover glasses hermetically. The gradual growth of the crystals forming during hydration could thus be studied under the microscope. As a rule it sufficed to magnify the objects 320 times in translucent light. For the observation of very fine structures the dark field illuminator proved to be of excellent service.

In order to distinguish the resulting chemical bodies, solutions were allowed to act upon them, for instance, pure water, water containing 3% acetic acid and water containing from 5% to 10% ammonium salts. The latter two reagents destroyed the crystals very rapidly, while pure water worked more slowly. Water containing carbonic acid and dilute oxalic acid solutions caused precipitates to form in the preparations which contained invariably calcium compounds and, therefore, impaired the observation.

Thus, the treatment of the microscopic preparations with solutions proved to be of little benefit. By far more successful, however, was a newly perfected staining process. The frequently applied method of staining preparations with salts of dye-bases, as recommended, for example, for the determination of silicic acid with malachite green, yielded, on account of the instability of the dye-base, no reliable results in alkaline solution, whereas this method worked well in acidous solutions. As, however, only alkaline solutions had to be considered in the present case, special dyes had to be selected which made possible, for instance, the exclusive staining of alumina compounds in alkaline solutions; and, on the other hand, dyes were required that stained silica alone, even if it was mixed with alumina.

Before the behavior of as complicated a substance as Portland cement towards solutions of dyes could be examined, it was necessary to subject its main constituents, silica, calcium oxide, alumina, separately to the influence of these staining solutions and to do this under conditions resembling the setting of cement as closely as possible. Besides, the most important compounds of silica and alumina with calcium oxide, that is to say, the calcium silicates and calcium aluminates, had to be examined. Out of several hundred dyes, those given in the following table proved to be especially adaptable for staining and for identifying the various substances in question. The first column of the table contains the names of the dyes tested and the others those of the chemical bodies subjected to the staining process. All cases, in which staining was successful, were marked by a cross. An attempt was made to let several dyes act upon the same substance one after the other; this, however, led in many cases to a mutual reaction between the various dyes and to a formation of beautiful crystals, which was found to be very misleading. The most suitable of all the dyes examined were methylene-blue in dilute acetic acid, safranin in acidous or alkaline solution, anthrapurpurine and, last not least, patent-blue.

Dyes:	Ca (OH)	Al (OH) ₃	SiO ₂ hydr.	3CaO Al ₂ O ₃	2CaO SiO ₂	Cement
Methylenblue			++			
Janusblue			++			
Tartrazine	+	++		++		
Rosebengal		++	+	++	+	+
Rhodamine		++		++		
Bibrich Scarlet	+	++		++	+	+
Erika	+	++		++	+	+
Ponceau		++		+	+	+
Safranin			+			
Alizarinbrowne		+				
Woolblack		++		+		+
Fluoreszeine		++		++		+
Chinolinyellow	+	++		++	+	
Patentblue		++		+	++	+
Cotton blue		++			++	
Tuchrot	+	++		+	+	+
Eosine	+	++		+	+	+
Acid-Fuchsine		++				
Acid Green		++		+		+
Anthrazenblue		++				
Heliotrope		++		+	+	+
Kongored	+	++		++	++	++
Deltapurpurine	+	++		++	++	++
Höchstler Neublau		++				
Chromotrop		++		+		+
Benzopurpurine		++		++		
Alizarinyellow GGW	+	++		++	+	+
Alizarinyellow Saphirol	+	++		++	++	++
Anthrapurpurine	+	++		++	+	++
Primulinyellow		+		+		+
Malachite Green			+			

The latter turned out to be an excellent reagent for alumina in alkaline solution. It withstood strongly alkaline solutions without losing its staining power, strongly colored alumina and aluminiferous substances and formed lacquers with them. However, patent-blue did not stain silica nor calcium hydroxide or calcium silicates and did not yield precipitates with lime-water, which was found to be in opposition to most basic dyes. Hence, it was a safe reagent upon alumina in calcium aluminates or in clays, if they were burnt with an access of lime.

The best stain for silica, if mixed with alumina, is methylene blue; however, it colors silica only after previous precipitation with acid, but not as silicate. As it gradually discolors in alkaline solution, it can be used exclusively in neutral or acidous solutions.

The acidous dye-solution generally precipitates the silica from silicates and thus renders it subject to staining. Saffranine acts in a similar manner; however, it was not used as extensively as methylene blue.

Calcium hydroxide could easily be detected by a solution of anthrapurpurine in alcohol, as this dye stained all calcium compounds very plainly.

Hence, these dyes enable us to stain alumina in alkaline solution, that is to say, in the condition in which it is contained in hydrating cements, and to distinguish it from silica and calcium oxide; furthermore, silica can be readily distinguished beside alumina by staining it in solutions previously made acidous. Patent-blue and methylene-blue are the stains most appropriate for this purpose.

B. Experiments and Results:

The Hydration of Normal Cements: In order to be able to interpret the nature of the chemical bodies forming during the hardening of cement, it was necessary to study once more the products of hydration observed by Ambrohn and to apply to them the dyes formerly mentioned. For these experiments two Portland cements were used which were manufactured in different ways. As previously stated the small amounts needed for observation were mixed with very little water, in order to copy as closely as possible the conditions under which cement hardened in practice. Moreover, much water delayed the process of crystallization and caused the pictures to be less distinct. In the case of both cements hydration progressed in the following way: During the first half hour, the cement grains covered themselves with short thick needle-crystals which, very soon afterwards, became visible as small hexagonal plates. Then very minute thin needle crystals, which were difficult to recognize, began to radiate from the cement grains, surrounding them on all sides. In some instances these needle-crystals could also be seen separately, that is to say, not in contact with the grains of cement. The crystallization of the needle-crystals continued for several days. The plate-crystals, which became visible from the very beginning of the process of hydration increased in size during this time and could soon be distinguished as regular hexagonal plates. Then formed, however only in small number, large hexagonal crystals which were lying by themselves or one on the top of another; some of them grew to such proportions that they covered the entire field of view. In growing, they surrounded everything within reach and, for this reason, needle-crystals, plate-crystals and even undecomposed cement grains could be seen enclosed by them. At the same time with these large hexagonal crystals, a colloidal mass formed, which grew as long as water was present until it covered everything.

In a preparation, which originated from underburnt cement, a few isolated sphaerulites could be noticed: these, however, were entirely different from sphaerulites composed of calcium carbonate, which formed only at cements hydrating in the air. They grew mostly from the edges of the cover glass and evidently did not contribute anything to the setting and hardening process.

To recapitulate, the essential products of hydration are the small plate-crystals, the fine needle-crystals, the large hexagonal crystals and the colloidal mass. All of these showed a characteristic behavior towards the staining solutions described in the foregoing. The solution of patent-blue was added while hydration was still in progress and, in the course of it, the plate-

crystals could plainly be seen to be stained. The dye did not adhere merely to the surface, but colored them throughout, as could be observed at crystals standing on edge which showed distinct dichroism (blue-white). However, if the staining solution was added only after the process of hydration had ended, the plate-crystals assumed but a superficial coloring. None of the remaining products of hydration was stained by it. As patent-blue was able to color only substances containing alumina, the plate-crystals of the preparations must have contained alumina in one form or another, whereas all other crystals, and also the colloidal mass, were free of it.

Anthrapurpurine in alcoholic solution colored the whole preparation, especially the large hexagonal crystals and the colloidal mass. Hence, all bodies created during the process of hydration contained calcium hydrate and principally the latter two.

Methylene-blue in pure water did not stain the preparation noticeably. The hydrated cement, therefore, did not contain free silica for, as formerly stated, only the latter was stainable by the dye.

However, methylene-blue in dilute acetic acid acted very strongly. The acetic acid destroyed the whole preparation and precipitated silica which, instantly, was colored by methylene blue. Of special interest were those parts of the preparation which contained



Colloidal mass forming around the cement grains. In the beginning the colloids contain much water and represent a semi-transparent mass of the appearance of thin jelly.

no crystals, but only colloids. Here the precipitation of the silica and simultaneous coloring could be followed very plainly. The colloidal mass, therefore, contained silica and this silica was combined with calcium hydroxide, as the staining with anthrapurpurine proved. It did not contain alumina, because patent blue did not color it. Hence the qualitative composition of the colloidal mass was cleared up by these experiments.

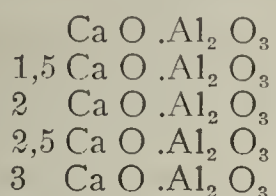
The microscopic picture which the process of hydration offers is changed only slightly, if sand is added to the cement. In the latter event, the long needle-crystals form on the surface of the sand grains and radiate in all directions. All other products of hydration form in the same manner as in the absence of sand.

The Hydration of Fused Products of Various Composition: For the purpose of obtaining the crystals forming during the hydration of commercial cements separately, fused compounds of known simple composition were produced and their behavior during hydration was studied under the microscope. The bodies

forming were subjected to the staining process formerly described. For the calcium aluminates, calcium silicates, calcium chromites, calcium ferrites and chromium—and iron-cements thus obtained by fusing the purest chemicals were used exclusively.

The only difficulty encountered consisted in attaining the necessary high temperature. The heat of a gas furnace did not suffice in every instance; besides the fire-clay and graphite crucibles were considerably affected by the fusing compounds; and even only slightly vitrified mixtures were able to combine with the crucible substance, much to our surprise. An electric arc-light furnace, with its carbon electrodes inclined at an angle of 60 degrees, proved to be the best adapted for our purposes. The mixtures that had to be burnt in this furnace were prepared in the following manner: The finely powdered mixture of the component parts was thoroughly mixed in a wet state and dried on a water-bath, ground once more, moistened with water and pressed into tablets in an iron mould. Several of these tablets were placed, one on the top of another, on the carbon support of the electric furnace. In this way, the upper tablet was within the arc-light, while those underneath protected it from the injurious influence of the carbon support. The temperature was raised only high enough to completely fuse the upper tablet; thus a uniform product could be obtained. As the heat within the arc-light was known to differ considerably, no temperature measurements were taken. Commercial cements, to be true, are not fused, but burnt merely to a point of beginning vitrification; however, fusing does not change their hydraulic properties, as Michaelis and others demonstrated. And, in fact, some of the normal cements, which were subjected to the fusing process, hydrated and hardened in precisely the same manner as the commercial products. After having cooled, the fused products were all ground so finely that all of it passed a 200-mesh sieve.

Calcium Aluminates: Five different mixtures of calcium oxide and alumina were thus fused, in which the amount of calcium oxide melted together with one molecule of alumina ranged from one to three molecules:



The melting point of the mixtures decreased steadily as the percentage of lime increased; the mixture containing three molecules of lime, therefore, required the lowest temperature. The fused products resembled porcelain; those low in lime were slightly translucent, while the higher-limed mixtures became more and more untransparent and assumed a bluish-white color. The finely powdered very hard fused products, especially the tri-calcium aluminate, showed distinct double-refraction under the microscope.

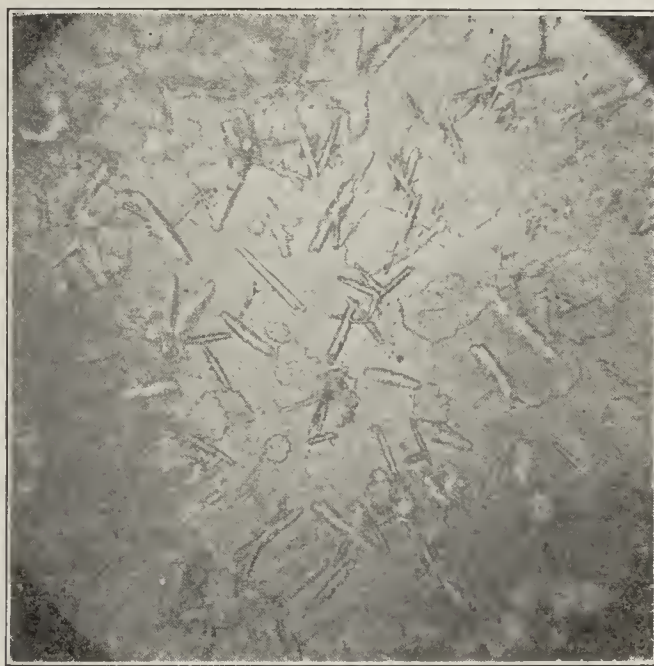
The mono-calcium aluminate showed the following picture upon hydrating: The minute grains were acted upon by the water very rapidly and each was soon surrounded by a halo consisting of a transparent mass. After 10 or 15 minutes needle-crystals were seen to form in the surrounding rings of many of the grains, which increased gradually in size. They formed likewise a distance from the grains, singly and also in groups, covering one another or radiating from a common center, and sometimes were 0.1 mm. long. They possessed prismatic shape and were double-refracting. Patent-blue stained them very strongly, hence, they contained alumina. Anthrapurpurine, serv-

ing as reagent upon calcium hydrate, acted in the same way. The needle-crystals are, consequently, composed of alumina and calcium hydrate. They are by no means identical with the minute needle-crystals of the commercial cement, described in a former chapter, for the latter were not stained by patent-blue and, moreover, showed different extinction in polarized light and had sharp-pointed ends.

Together with the formation of the fine needle-crystals sphaerulites formed at a few places by the growing of needle-crystals radiating in all directions from one point and by the covering of the circumference of this conglomeration with a less transparent thick crust that grew the same as the crystals and assumed at times elliptic shape. The sphaerulites were stained by patent-blue and anthrapurpurine in the same way as the formerly described needle-crystals, hence consisted likewise of calcium aluminate. To judge from their exterior, their optical behavior and faculty of being stained by patent-blue and anthrapurpurine, they are identical with the sphaerulites occurring now and then in underburnt commercial cements.

An hour or two after the beginning of the growth of the needle-crystals and sphaerulites, the whole preparation began to be covered with a colloid mass, which was but slightly translucent, so that from now on the crystals could be observed only with difficulty. The colloidal mass was stained by patent-blue almost as strongly as pure alumina hydrate, while anthrapurpurine colored it but faintly; hence, it consisted almost entirely of alumina hydrate.

These observations readily explain the remarkable strength of the hydrated mono-calcium aluminate recorded by Schott (see Cement & Engineering News December 1910 page 515). The long fine needle-crystals interlace intimately during hydration and are firmly cemented together by the colloidal alumina hydrate.



Crystals begin to form within the colloids coating the cement grains, as it were, with a film of glue. The cement is still plastic, but the colloids become less translucent.

The fused product containing one and one-half molecules of calcium oxide to one of alumina exhibited a somewhat different picture under the microscope. In this case sphaerulites were formed in large number, whereas only few needle-crystals could be seen. Thus, the ratio in which these two crystal groups occurred was reversed. The colloidal mass, however, formed in a like manner in the course of about two hours. The preparation was stained in exactly the same way as the foregoing.

Four hours later, the last preparation showed a novel and very interesting feature, namely accumulations of plate-crystals, which formed at numerous places and were evidently independent from all former bodies. Some of them were distinctly hexagonal. They were stained by patent-blue, but less strongly than the remainder of the preparation and, therefore, obviously contained less alumina than the other constituents. Anthrapurpurine, however, colored it intensely thus indicating the presence of a high percentage of lime. Their resemblance with the hexagonal plate-crystals observed in Portland cement was remarkable, so much the more so as both were stained by patent-blue to the same degree.

If the second preparation was made with lime-water instead of distilled water, these plate-crystals could be observed right from the beginning of the process of hydration. This serves to show that the existence of a surplus of lime is conducive to the formation of hexagonal plate-crystals.

The same plate-crystals formed an essential part in all of the remaining fused lime-alumina mixtures, which contained two, two and one-half and three molecules of calcium oxide to one molecule of alumina. Outside of them, no crystal formation became visible, so that the well-known colloidal mass formed the only other constituent. The hydrated di-calcium aluminate showed distinctly a smaller amount of colloids than the first two preparations, as on account of the higher contents of lime more alumina was required for the formation of calcium-aluminate crystals. The hexagonal plates were very numerous and could mostly be seen lying on the flat side in the preparation. They increased still further in number in the preparation made from the fused product containing two and one-half molecules of calcium oxide to one of alumina, while the colloidal mass decreased in proportion. In the latter preparation, the plate-crystals grew out of the grains and stood partly on edge. Finally, the hydrated tri-calcium aluminate did not show any colloids, the preparation being composed entirely of closely packed hexagonal plate-crystals standing on edge. The fact, that the colloidal mass disappeared upon subjecting the fused tri-calcium aluminate to hydration, whereas all former fused mixtures, containing less lime, exhibited, upon hydration, colloidal alumina hydrate, showed plainly that the plate-crystals represented tri-calcium-alumina hydrate. In the following further proofs will be given for this.

If only a single grain of the fused tri-calcium aluminate was placed in much water, it went entirely into solution and soon the well-known hexagonal plate-crystals began to form, mostly standing on edge and grouped around a central point. A similar observation was made by Le Chatelier, Gino Gallo and others in the course of the following experiment: They filtered the suspension of a slightly basic calcium aluminate and added lime-water to the filtrate. As the result, crystals formed which were regarded by the experimenters as sphaerulites, which, however, closely resembled the formerly described conglomerates. The analyses made by both chemists really showed the crystals to be a tri-calcium-alumina-hydrate containing 12 molecules of water.

The hexagonal plate-crystals, the composition of which seems to be established herewith, are likewise to be found in hydrated Portland cement, as stated in the foregoing. They form during the hardening of cement just as well as during the hydration of tri-calcium aluminate gauged with a small amount of water; besides they have the same shape and size, the same optic properties and are stained by dyes in the same manner. (To be continued)

IMPROVED HYDRAULIC CEMENTS; PORTLAND CEMENT REGROUND WITH TUFAS.

By Edward Duryee.

[Paper read at the meeting of the Engineers and Architects' Association of Southern California, December 6th, 1910.]

All who have been engaged in the development of the Portland cement industry are proud of the mechanical and technological excellence of American processes and the reliable character of the numerous brands of Portland cement now on the market. Manufacturers are grinding to greater fineness, burning the cement better and in every particular exercising greater care than ever before in turning out uniform, sound and high-grade products.

Although the cement is of higher grade than formerly, still, in general use in concretes, it goes no further, the color is no better and the concrete is no denser than was formerly the case.

The writer has been impressed by the frequent complaints of leaking reservoirs, tunnels, cellars and walls of buildings, by the discolored superstructural walls of buildings and the occasional destruction of mortars in sewers and harbors. It is therefore with a conviction of the need as well as the possibility of improvement that he advocates the use of the silicious-Portland or Puzzolan-Portland cement now being used to a considerable extent on the Los Angeles aqueduct and which is the product of regrinding Portland cement with puzzolana. The eastern states are virtually precluded from using such a mixture because of the lack of natural puzzolanas, but the Pacific Coast abounds in immense and unused deposits of the very best grades of these materials, and is thereby qualified to lead the cement industry in this line.

There is an universal field for an improved Portland cement that shall secure mortars permanently waterproof and of better color for architectural purposes and it is for the purpose of explaining this and calling the attention of engineers and architects to the means for obtaining this cement that this paper is prepared.

It is well known that the finer ground cement and tufas are, the greater is their hydraulic efficiency, and the more completely they will fill the pores of the mortars. This filling the pores of the mortars is the only effectively permanent method of making mortars waterproof and by using a finely ground cement and puzzolana this may be accomplished. In finely ground puzzolanas the silica is in an active or "soluble" form capable of uniting with hydrated lime and forming crystals to fill the pores of the mortar in a colloidal form. We may depend upon these crystallized compounds retaining their voluminous condition permanently whereas many waterproofing compounds in common use are composed of colloidal solutions that will shrink under alternate wet and dry conditions and in time lose their efficiency.

Some Los Angeles Aqueduct Tests.

A series of experiments were undertaken in 1908 with sands obtained along the line of the aqueduct in the Owens river region, the object being to determine what materials might be added to the concretes to render them impermeable to water and how these additions might effect the strength of concretes.

The samples of sand were tagged numbers 1 to 6. Mechanical analyses for fineness were made from No. 1 and No. 2, and the remaining samples were mixed and an analysis made of the average of Nos.

3, 4, 5 and 6. One sample of California brand of Portland cement was used in all the concrete test cylinders. Test piece "A" was made with No. 1 sand; piece "B" with No. 2 sand; and pieces "C," "D," "E" were made with the average of Nos. 3, 4, 5 and 6 sands. Briquettes were made from the mortar used for the permeability tests in each case in order to determine the effects of the waterproofing materials on the strength of the concretes.

The molds used for making the cylindrical sections of concrete were prepared by taking cast-iron caps for six-inch pipe, tapping out the solid cap end to reduce for three-quarter inch nipples for connection to the water pressure pipe line. The straight sides were also channeled with two circular channels, to enable the concrete to bond strongly to the iron shell. By the use of these forms concrete cylinders six inches in diameter and six inches high were obtained. The concretes were left in the forms throughout the tests.

"D" Concrete—

Average sands, $9\frac{1}{2}$ pounds; stearate of lime, 2 per cent; Portland cement, 3.2 pounds. The materials were mixed dry and 19 per cent of water was added. The mortar was not so fat and was wetter than previous mortars containing clay. The tensile strength per square inch of the briquettes was as follows:

14 days.....	140 pounds
28 days.....	200 pounds
2 months.....	216 pounds

"E" Concrete—

Average sands, $9\frac{1}{2}$ pounds; Portland cement, 3.17 pounds; water, 19 per cent. No water-proofing mixture was used. The tensile strength per square inch of the briquettes was as follows:

14 days.....	112 pounds
28 days.....	206 pounds
2 months.....	186 pounds

Fineness of Owens River Sands.

	No. 1	No. 2	Av'ge 3, 4, 5, 6
Passing $\frac{1}{4}$ -inch mesh: All.....			
Passing $\frac{1}{4}$ -inch and left on No. 10 screen.....	43.24	7.4	5.4
Passing No. 10 and left on No. 20 screen.....	22.54	13.0	27.0
Passing No. 20 and left on No. 30 screen.....	10.85	14.9	19.2
Passing No. 30 and left on No. 40 screen.....	6.28	12.2	10.2
Passing No. 40 and left on No. 200 screen.....	16.02	50.9	33.0
Passing No. 200.....	1.32	2.7	2.4
Totals.....	100.25	100.1	97.2

"A" Concrete—

No. 1 sand, 9 pounds; dry, ground Tehacapi clay 5 per cent or 0.63 pounds; Portland cement, $3\frac{1}{4}$ pounds. The materials were mixed thoroughly dry, then 19 per cent of water made milky with slaked lime was added and the mortar was thoroughly mixed wet. The mortar worked fat and of good consistency. The tensile strength of mortar briquettes was:

14 days.....	190 pounds
28 days.....	198 pounds
2 months.....	262 pounds

"B" Concrete—

No. 2 sand, $9\frac{1}{2}$ pounds; dry, ground Tehachapi clay, 2 per cent or $\frac{1}{4}$ pound; Portland cement, $3\frac{1}{4}$ pounds. The materials were mixed dry, then 1021 cubic centimeters of water containing 23 grammes of alum, equivalent to a $2\frac{1}{2}$ per cent solution of alum, was added. The water was 22 per cent of the mortar. The mortar worked stiffer than "A" and stood some tamping in the mold before it quaked. The tensile strength per square inch of the mortar briquettes was:

14 days.....	176 pounds
28 days.....	284 pounds
2 months.....	296 pounds

"C" Concrete—

Average sands, $9\frac{1}{2}$ pounds; dry, ground Tehachapi clay, $\frac{1}{4}$ pound; hydrated lime, 0.44 pound; Portland cement, $3\frac{1}{4}$ pounds. The materials were mixed dry, then 1,000 grammes of water carrying $2\frac{1}{2}$ per cent silicate of soda was added. The tensile strength per square inch of the briquettes was as follows:

14 days.....	134 pounds
28 days.....	200 pounds
2 months.....	236 pounds

Briquettes were also made with standard testing sand for comparison of tensile strengths of the preceding mortars with standard mortars. Two sets were made, the "wet" mortar being made with 19 per cent water (the quantity used in the concretes made for the test cylinders), and the "dry" mortar being made with 10 per cent of water.

The tensile strength per square inch, with the standard sand, was as follows:

Mortar	14 days	28 days	2 mos.
"Wet"	176 lbs.	230 lbs.	302 lbs.
"Dry"	240 lbs.	246 lbs.	294 lbs.

Treatment of Test Cylinders.

The test pieces were all made on the same date and under the same conditions. They were all kept damp for one month, and were then connected with the Los Angeles City water main, under sixty pounds pressure, continuously for twenty-four hours. At the end of this time the "E" block showed sweating on the lower end, but all the others remained perfect. The pressure was continued for a month continuously, without any change. During all this period all the treated mortars remained dry on the lower surfaces, but the untreated block was always damp, although not enough water to measure percolated through it.

After a month's pressure of 60 pounds, the pressure was raised by hourly stages for six hours, as follows:

9:15 a. m.	60 lbs.
10:15 a. m.	80 lbs.
11:15 a. m.	100 lbs.
Noon	Few drops "E" block alone
1:15 p. m.	120 lbs.
2:15 p. m.	150 lbs.
3:15 p. m. (for 1 hour)	200 lbs.

No change was noticed and none was damp with the exception of "E."

Conclusions.

1. The use of any one of the water proofing materials tried in these experiments, with these sands, rendered the six-inch concrete masses practically impermeable under favorable conditions and during the period of the tests.

2. For the purposes of the Los Angeles Aqueduct, the addition of small percentages of ground clay and hydrated lime answer the purpose as well as do the other mixtures tried. Concrete in the Aqueduct will be perpetually wet.

3. The addition of these materials did not during the two months period of the testing affect injuriously the strength of the concrete; this might not hold true for long periods.

The above experiments were made before the Portland-tufa cement proposition was developed.

The use of the reground tufa-Portland cement would evidently afford a denser, more perfect waterproofing medium, as it is finer ground than the cement used in these experiments, and the tufa with hydrated lime is a permanent colloid to fill all pores.

White Architectural Cement.

White Portland cement, at present imported from eastern factories and sold at high prices in the Pacific Coast market, may just as well be manufactured in California, and as white puzzolans for waterproofing it are found in this state, a superior white cement for architectural purposes to any now on the market could be produced here.

When there is a general enough demand for it to assure a local market, its manufacture will be undertaken. Even at the present high price of the imported cement, it is growing rapidly in favor, and architects have only to demand it in considerable quantities to lead to its local manufacture and sale at lower prices.

White Portland cements mixed with white and colored sands are being used to produce the handsomest art stone, as well as white and gray plasters. By the use of white cement and sand any desired stone, in color, texture and detail, can be produced by the addition of mineral colors.

The addition of white puzzolana will prevent the sometimes mentioned complaint of dampness and efflorescence on cement stone and plastered surfaces, whatever their color. Sometimes it is not realized that in order to secure uniformity in color, texture and finish on any certain job, the materials must be uniform, the quantity of water used must be uniform, and the work throughout must be exactly the same.

Stone or plasters made from white Puzzolan-Portland cement mixed with white sand will take any mineral color truer and better than the dull colored ordinary Portland cement and sand, producing a surface to meet the artistic specifications of the architect. Such surfaces will remain true in color permanently. The white, light gray, olive or cream colors possible with these cements and sands are very desirable for both inside and outside walls of modern office buildings where it is necessary to secure abundance of light. Walls plastered with this mortar, being waterproof, may be washed when soiled.

Cement for use in Sea Water.

Harbor engineers are vitally interested in obtaining a hydraulic cement that will insure the permanency of concrete construction in sea water.

Portland cement in recent years has been fast superseding all other hydraulic cements for general engi-

neering constructions, and has been freely used in the United States for breakwaters, wharves, piles and foundations for bridges. For several years, however, its permanence in sea water has been disputed, and in some European countries, when it has been used in sea water, the practice of mixing ground tufa with it has been followed. The German authorities have finally adopted the recently patented Krupps' iron ore cement for all construction in sea water.

The results of tests on the behavior of hydraulic cements in sea water covering a period of five years, have appeared in a report of the Royal Testing Laboratory of Germany, under the title of "Mitteilungen aus dem Kgl. Materialprüfungsamt." These results show the advantages of Puzzolan-Portland cement, particularly in lean mortars, and for long periods. A review of this report lately published in English by H. Burchartz, in *Engineering Record*, Aug. 27th, 1910, is said to present the results in as unfavorable a light as possible to puzzolan mixtures. In very rich mortars, straight Portland cement mixtures are stronger than those of puzzolan-cement. These rich mortars are not however used in practice, and in ordinary proportions the puzzolan mixtures show superior strength and economy.

In experimenting with puzzolan mixtures, some unfavorable results have been obtained when the materials have not been properly prepared, as for example, the report of an Austrian Architect's Association, in which the tests were made with a mixture of cement and puzzolan, wherein the trass was so coarse that half of it failed to pass a fifty-mesh sieve. Fineness of grinding and uniform mixing are of course essential in securing good results.

In a laboratory way, Bleininger ground Portland cement and puzzolan together in equal proportions, and the product showed a much greater resistance to the action of acidulated water than did straight Portland cement. He suggested, "If practice should confirm this suggestion, the durability of exposed cement surfaces, such as sea-walls, cement blocks and reservoir walls, could be thus improved cheaply and satisfactorily."

"It should be the task of Portland cement manufacturers to study these questions and prepare for the market, cements especially suitable for exposed work. Much of the lack of confidence which existed in certain quarters in years past regarding the use of cement would thus be eliminated."

Regrinding.

By regrinding ordinary Portland cement, the proportion of flour cement, the active part of cement, which by crystallization gives strength to mortars, is greatly increased. The process of grinding puzzolans with cement exceedingly fine, brings the active silica of puzzolan into intimate contact with the particles of the cement, and they take part in the chemical rearrangement of the crystallization attendant on adding water. There is thus obtained an auxiliary hydraulic reaction, and the primary strength of Portland cement is increased by the strength of puzzolan cement. This increased strength is rendered all the more valuable in that the mortar is given a highly silicious character, and thereby rendered more proof against chemical action, while the fine grinding contributes to the greater impermeability of the mortar.

In Italy, the old Roman cements have always been used, and there are quay walls, aqueducts and buildings standing there as old as the Christian era. The following information on Roman cement was furnished by H. M. Koll of Los Angeles.

Retaining Walls on Tiber River.

The Roman cement was composed sometimes of nine parts of puzzolana or volcanic scoria, mixed with one part of slaked lime; in other cases, for use underground, two parts of Vesuvian puzzolana was mixed with one part of slaked lime.

In building retaining walls along the Tiber, the wall proper is first laid up with blocks of tufa as quarried, in sizes of 8 to 13 inches, laid in the last mentioned mortar; no sand is used in the mortar. The wall is then faced with hewn travertine in blocks of 18x30 inches, and the whole is then curbed with Peperino; this latter stone is mostly used for trimmings, sills, curbs and cornices. Travertine was extensively used by the ancient Romans for monumental buildings, such as the Colosseum, Aqueduct and the Church of St. Peters.

The puzzolan earth used for mortars is said to cost about 54 to 80 cents a cubic yard.

Naples.

Puzzolan di Bacoli is quarried near Puteoli, at Bacoli, and is used here. It is used as mined and to make cement. To make cement two parts of this are mixed with one part of slaked lime, and one part of this cement is mixed with two parts Vesuvius stone (broken lava), about walnut size. This is used for concrete for foundations and water front buildings. The formula for concrete claimed to be as good as was used by ancients is:

Puzzolano di Bacoli, 2 parts.

Slaked lime, 1 part.

Vesuvius stone, 6 parts.

Water to work properly.

The price of this mineral is 2½ lire a cubic meter, or 50 cents for 1¼ yards, and at wholesale, 2 lire a cubic meter, or 40 cents, equivalent to 32 cents a cubic yard. It is exported to South America.

The Italian cements were not ground nearly so fine as is advocated in this paper, and on that account were not so dense.

Salts in Sea Water.

Many cement investigators in recent years have reached the conclusion that sea water contains sulphate salts which, if allowed to penetrate a Portland cement concrete, will react on some of the lime and alumina in the cement, changing its volume, swelling and destroying the cohesion of the mortar. The correctness of this conclusion has been disputed by many, and the many experiments undertaken abroad to demonstrate it are not yet conclusive either way. Periods of observation extending over lengths of ten, twenty or thirty years are needed, for the action is very slow. In sea water the salts are present in extremely diluted condition, for in 1000 parts of sea water there are only 36 parts of salts, and of this only about 2¼ parts are sulphuric acid, and this in combination with bases.

In commenting on the above subject, the Engineering News of July 18, 1907, calls attention to the intertidal surfaces of concrete, as follows, quoting a letter from the engineer of the New York, New Haven & Hartford Railroad:

"We find a disintegration of concrete where exposed to the action of tides—disintegration between high and low tides, due perhaps to sewage and mill refuse—and are using stone in preference to concrete at Pelham Bay and Bronx River bridges. The concrete

piers at old City Bridge at Pelham Bay show considerable disintegration near low water line.

"Admitting that a hard, non-porous concrete surface may be safe against any harmful action of sea water not polluted with strong acids, the position of the inter-tidal sections is peculiarly difficult, being liable to wave action and floating debris, to destroy the density of the surface, which, when once penetrated, the sea water can have full play against the concrete."

The superiority of concrete over timbers in any condition will be understood when it is noted that the teredos destroy untreated wooden piles in less than two years on the Pacific Coast, while Portland cement concrete is not affected by these destroyers, and on the Pacific Coast, where the climate eliminates the physical changes due to freezing and thawing, it should be good for at least ten to twenty years if properly made. There have been other instances in the East where Portland cement concrete has not stood satisfactorily in sea water; another of these is the United States Government dock at the Charlestown Navy Yards, Boston Harbor, built in 1901, under the requirements of the officials of the Navy. Quoting from the account given in the Engineering News, August 27, 1908: "The photo shows extended decomposition of the walls extending well into the concrete. The facing was three inches thick, of a mortar of one part cement to one part sand; this was used on all exposed surfaces. Extending two feet back of the facing, the concrete was a 1-2-4 mixture, and back of this, in the interior, 1-3-6 mixture was used.

"In addition to the usual standard specifications was this clause: 'The Contractor must furnish satisfactory evidence of the durability in sea water of the cement he purposes to furnish.'"

"The arches are 20 feet span, not reinforced, and the decomposition extended into the mass a considerable distance. A dry tamped mixture was used, and without any waterproofing compound. The structure stands in tidal water, subject to alternate freezing and thawing. The damage occurs mainly between tide levels."

Commenting on this Charlestown case in the Engineering News of September 24, 1908, the secretary of the Aberthaw Construction Company attributes the decomposition above noted to freezing and thawing of the mass, and says the work which the writer's company has done in the past eleven years has taught the difficulty of getting an impervious concrete. In the Charlestown job, many parts ring under hammer blow. These sound spots are found composed of concrete made of small pebbles of graded sizes, a dense, impervious masonry. The spots made of badly graded aggregates, and in some places but little stone, have disintegrated badly.

"An examination of the Buffalo, N. Y., breakwater by the writer showed that the surfaces showed some wear. This was in fresh water, and was due to wave and frost action. The conditions were not a fraction as bad as those at Charlestown."—M. C. Tuttle, Secretary.

W. Michaelis, in the same paper states: "European experience shows that Portland cement concrete used in sea water may resist the action of sea water sometimes for a considerable period, but that softening of the surface, and consequent disintegration of the mortar, is bound to come in time, that is to say, if not in ten years, then in twenty or thirty years, certainly within the second or third decade. The sulphuric acid salts contained in the sea water combine with some of the lime and alumina in cement, and destroy the cohesion of the mortar by a process of crystallization."

Prevention of Deterioration.

It is conceded by the best cement investigators that there is liability of chemical deterioration in Portland cement concrete exposed to sea, sewage and alkaline water, unless means be taken to prevent it. Fortunately, this can be accomplished by specially preparing the cement by grinding with it a puzzolana; as mentioned in the opening of this paper, this practice has been followed in Europe, and it should be adopted in America. Quoting from an editorial in the Cement and Engineering News for August, 1910, on the waterproofing qualities of colloids: "Waterproofing has frequently to be resorted to. This is especially true in sea water, sulphur and alkaline water (sewage waters included), in which cases the waterproofing compounds prevent the decaying influence of the chemicals dissolved in the water. * * * Effective waterproofing and protecting of Portland cement in water containing corroding salts is only possible by the admixture of substances which are principally composed of the three colloids, silica, alumina and iron oxide, the elements contained in cements, besides the calcium oxide. Such substances are termed puzzolanas, artificial or natural, and are found in the form of volcanic lavas, or are obtained by granulating blast furnace slag or by drying or baking clays or shales. In Portland cement mortar the lime, becoming free in the process of decomposition following the mixing of the hydraulic cement with water, acts upon the colloidal bodies (of which silica is the most effective, and alumina the least desirable, with iron oxide taking an intermediate position), and swells them slightly, in a similar way as rice grains swell in boiling water."

Another editorial in the September number of the same paper concludes as follows: "In a number of years, without doubt, some of the extensive puzzolana deposits of the West will be exploited, and cement

The writer submits the following specification for a waterproofed hydraulic cement which it would be possible to supply in the local market, and which would meet the conditions advocated by authorities on waterproof cement for sea and other impure water construction, as well as for general use.

Proposed Specifications for Waterproofing Cements.

The base of the cement and composing at least 50 per cent by weight of the product shall be Portland cement.

Fineness—

This cement shall have been reground with puzzolan, the amount named in this contract; the finished product to contain from 10 to 50 per cent puzzolan, the finished cement having a minimum fineness of 90 per cent, passing through a 200-mesh screen. Hydrated lime may be an element of the cement for some purposes and by express agreement.

Note.—It will be noticed that the changes in standard cement specifications proposed involve finer grinding, omitting or lowering the neat tensile tests, slower final setting and lime, particularly alumina, which is the constituent most liable to decomposition from the action of impure waters.

Composition—

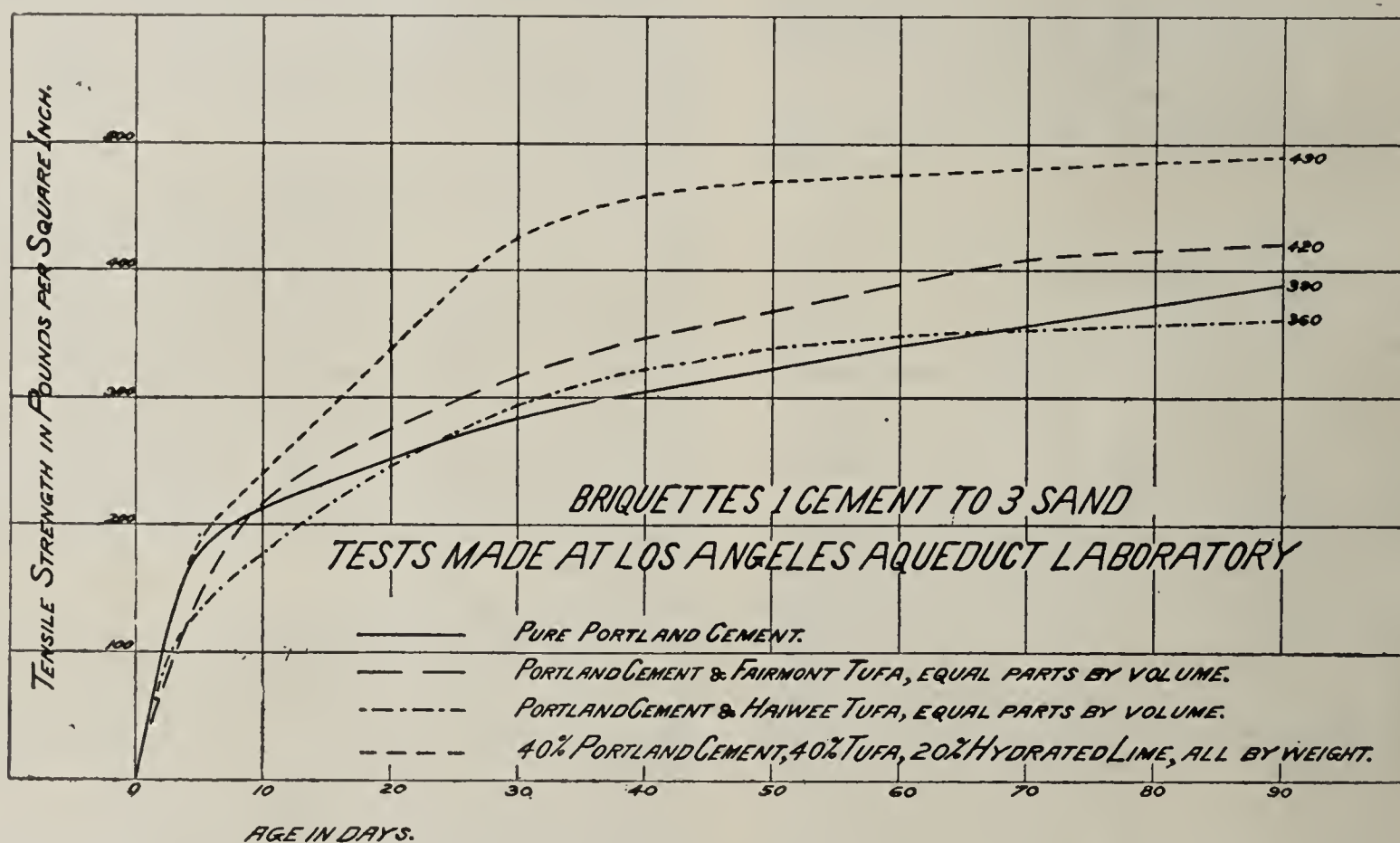
Preference will be given to a cement showing a minimum percentage of alumina.

Time of Setting—

It shall develop initial set in not less than thirty minutes, and final set in not over twelve hours.

Tensile Strength—

The minimum requirements for tensile strength for briquettes one inch square in section shall be as follows, and shall not show retrogression within the periods specified:



users will be able to buy natural puzzolanas in large quantities at a moderate price. Today, unfortunately, the American market does not offer anything but high-priced products in this line."

California is well supplied with deposits of natural puzzolanas, and it is easily possible to furnish the western cement market with superior waterproof Puzzolan-Portland cements advocated in the above quoted editorials in the Cement and Engineering News.

One part cement, three parts standard testing sand.
 One day in moist air and six days in water, 200 pounds.

One day in moist air and twenty-seven days in water, 300 pounds.

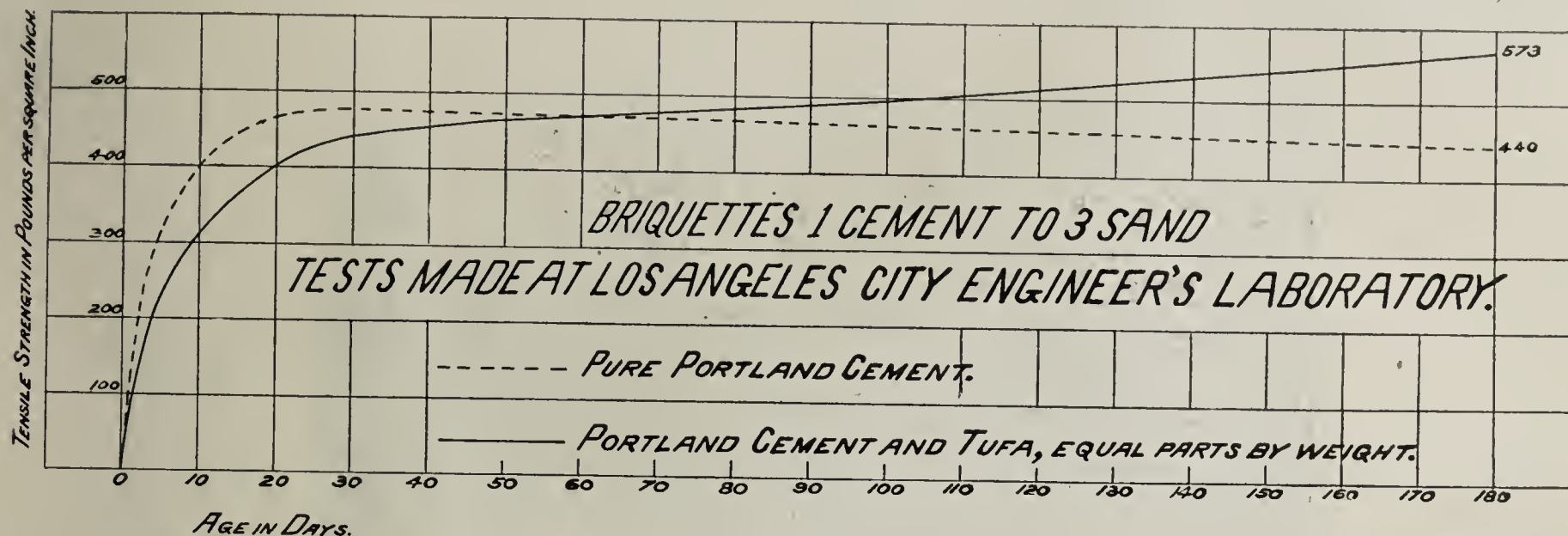
Neat tensile and specific gravity tests will not be required, but crushing and permeability tests are recommended where facilities permit.

Soundness—

Pats made in the usual way and submitted to the boiling test shall remain hard and show no signs of disintegration.

Note.—It will be noticed that the changes in standard cement specifications proposed involve finer grinding, omitting or lowering the neat tensile tests, slightly

The accompanying cement diagrams were made up by using averages of many tests, and demonstrate several interesting points. By far the strongest exhibit of tufa mixtures is that shown by the mixture of 40 per cent Portland cement, 40 per cent tufa and 20 per cent hydrated lime, ground together. This product proved stronger than pure Portland cement mortars, as fol-



slower final setting time, and the addition of a puzzolan, and when wanted, hydrated lime.

Hydrated Lime and Cement Mixtures—

The colors of cement mortars, as well as their adhesiveness and hydraulic strength, is improved by the addition of hydrated lime; it also adds to the density and plasticity of mortars, at the same time that the mortars remain safe and sound, complying with the common tests for Portland cement mortar.

Puzzolan-Portland Cement on Los Angeles Aqueduct.

The writer has been investigating deposits of puzzolanas in California during the past three years, and has had charge of building and operating, for the first season, two mills on the line of the Los Angeles Aqueduct for the regrinding of these puzzolanas with Portland cement. Deposits of tufa were found near the line of the Aqueduct at convenient points, one at Fairmont, near the southern end of the Aqueduct, where mill No. 1 is located, and another at Haiwee, where mill No. 2 is located. Each mill, completed, cost about \$25,000. The output of both plants has been about 100,000 barrels, which has gone into the construction of the Aqueduct. Satisfactory construction work has been done with the cement; the accompanying stress curves demonstrate the excellent strengths of the cement, but do not, of course, show its waterproofing character.

These mills were erected by the City of Los Angeles on the recommendation of William Mulholland, chief engineer of the aqueduct.

Composition of L. A. Aqueduct Tufa.

Silica	67.10	70.40
Alumina and Ferric Oxide	15.6	15.92
Lime	2.01	1.16
Magnesia	1.75	
Alkalis and Moisture	not found	

Weights of Material.

	lbs.
1 cu. ft. "Monolith" Portland Cement, loose.....	88
1 cu. ft. "Tufa-Monolith" cement (equal parts by weight Tufa and Monolith together).....	69
1 cu. ft. "Tufa-Monolith" cement, shaken down.....	80
1 cu. ft. Tufa, coarse ground alone in ball mill.....	69
1 cu. ft. Tufa alone, fine ground in tube mill.....	55

lows: In seven days, twenty pounds stronger; and in 28, 60 and 90 days, about 100 pounds stronger at each period.

The mixture of 30 per cent tufa and 60 per cent Portland cement showed about the same strength as the mixture of 62½ per cent tufa and 37½ per cent Portland cement. All three of the above mixtures showed higher tests than the clear Portland cement mortars at all periods after 28 days.

Advantages of Puzzolan-Portland Cements.

1.—In California, Portland cement with puzzolanas ground with it is much finer ground than ordinary cements, 90 per cent passing the 200-mesh screen.

2.—The reground cement with puzzolana is unfailingly sound.

3.—It makes a smooth, impermeable surface, proof against the chemical action of sea water and sewage and alkali.

4.—This cement exhibits a more continuous ratio of increase in strength in sand mortars and for longer periods than is true of ordinary commercial Portland cements.

5.—While the mixed Portland cement and puzzolan cement is superior to Portland cement, it can be sold at lower prices than commercial Portlands in the California markets, on account of the abundance and availability of local puzzolana deposits.

6.—This Puzzolan-Portland cement produces a surface of more uniform and lighter color, and less liable to unsightly lime efflorescence. Using a correct proportion of water and with the addition of puzzolan containing active silica to combine with the lime, largely eliminates the lime stains.

7.—The puzzolana-Portland cement possesses greater volume in equal weights.

Of these tests, the 90-day sets were made in the laboratory of the Los Angeles Aqueduct cement mill, and 180-day sets in the City Engineer's Laboratory. All the mixtures except the one containing slaked lime, which was ground in a laboratory ball mill, were ground in the Aqueduct regrinding plants at Fairmont and Haiwee, and the samples were taken from cement used in the construction of the Aqueduct.

WASHED VERSUS UNWASHED SAND AND GRAVEL.

The accompanying cuts illustrate the machinery used at a washing plant for sand and gravel.

As it has long been realized that reliable concrete work can only be done with sand and gravel absolutely free of loam and dirt and as a great number of fail-

contractor himself usually erects a washing plant in the immediate vicinity of the construction.

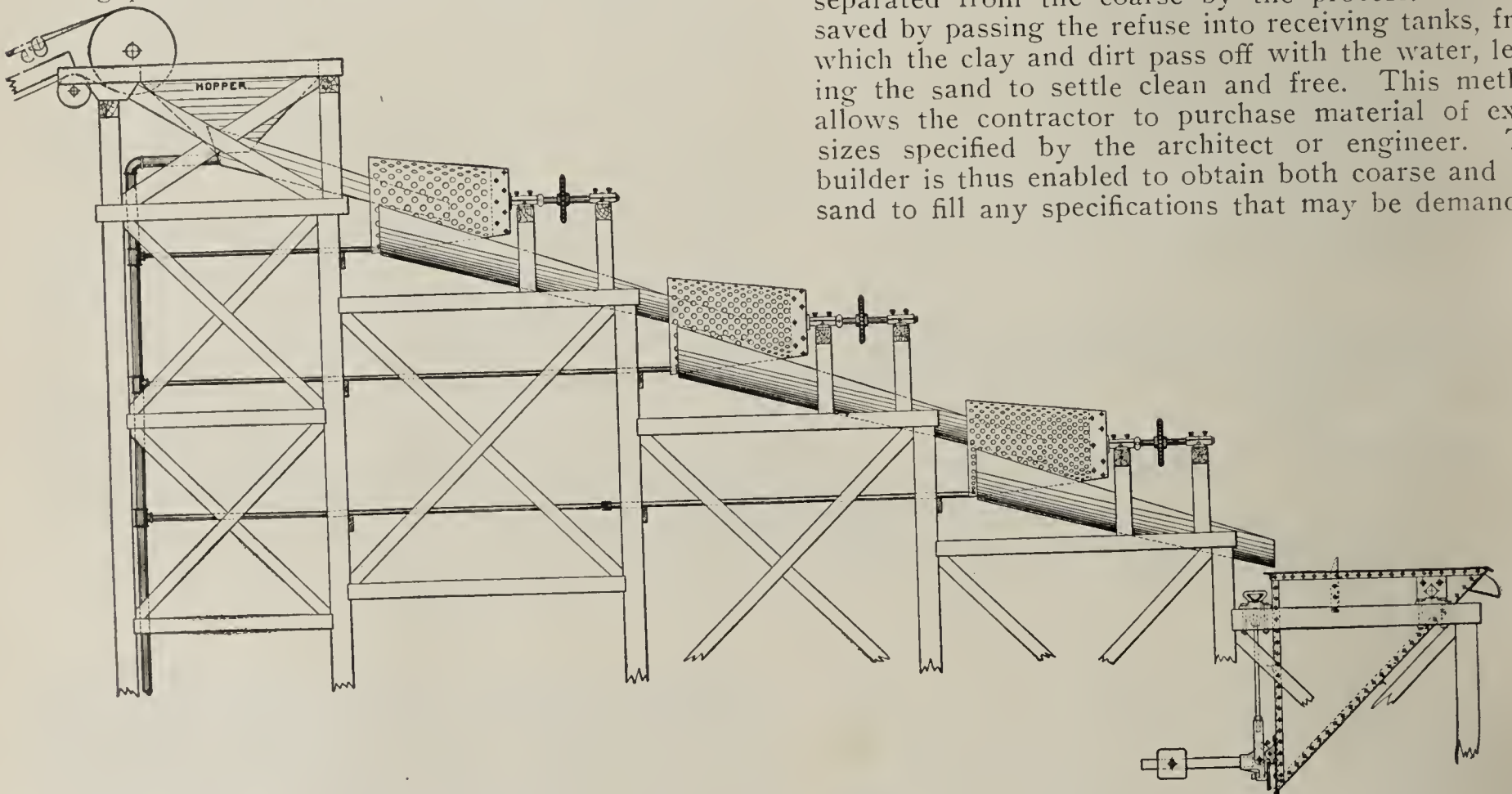
Sand and gravel when pumped or dredged from the bottom of rivers and lakes are not fit for use without being first washed by a process that will roll and tumble it in fresh circulating water; the particles are generally coated with slime and dirt that can only be removed in a washer.



Gravel Washing Plant of the Southern Gravel and Material Company at Brookhaven, Miss. Belt Conveyors, Transmission Machinery and patented "Gilbert" screens furnished by Stephens, Adamson & Co., Aurora, Ill.

ures in concrete construction, which in the beginning were attributed to inferior cement and poor workmanship, were ultimately found to be due to the use of sand in the state in which it was taken out of a river or gravel pit, all wise contractors see carefully to it nowadays that the materials used in the making of concrete are subjected at the quarry to a thorough washing process. In works of large proportions, the

The best principle for a washing plant is one that will roll and tumble the sand and gravel in a rapid running stream of water. It should also size the gravel and allow the oversize stone to fall into a crusher which will redeliver its product to the first washing screen, thereby saving and washing all the product of the bank. The successive steps of screens will make any number of sizes and the fine sand can also be separated from the coarse by the process. Sand is saved by passing the refuse into receiving tanks, from which the clay and dirt pass off with the water, leaving the sand to settle clean and free. This method allows the contractor to purchase material of exact sizes specified by the architect or engineer. The builder is thus enabled to obtain both coarse and fine sand to fill any specifications that may be demanded.



This drawing shows a standard gravel washing plant arranged for producing 3 sizes of gravel and sand. Patented "Gilbert" washing screens and automatic steel settling tank together with belt conveyors comprise the unique features of this system. Large capacity and clean product is the result. Manufactured by Stephens-Adams Mfg. Co., Aurora, Ill.

A NEW SYSTEM OF MIXING, CONVEYING AND DISTRIBUTING CONCRETE.

Engineers, architects, contractors, and builders will be keenly interested in a new system of handling and distributing concrete—

Not that the idea is new, for many crude attempts have been made to shoot concrete by means of gravity through troughs or pipes.

What is actually new and significant is that out of these crude attempts has evolved an apparently highly developed and perfected system—

That this system includes practical, simplified appliances of general utility consisting of suspended pipe, swinging boom, and universal swivel—

That this process and its appliances, which are vital to the success of a gravity system are fully covered by basic patents—

That exact engineering data covering every problem of construction by this system has been formulated and made available—

And that the system effects radical reductions in the number of men required on a job, big economies in operation, and affords ideal concrete for monolithic construction.

The G-Y System of mixing, conveying, and distributing concrete originated in southern California, where it was developed and perfected in actual construction work before it was given any wide publicity. Its use gradually spread over the Pacific Coast where there are now no less than twenty-four plants in operation. The volume of inquiries which have poured in upon the owners is an evidence of the intense interest in the device and the possibilities of the system.

The system is now being introduced throughout the entire east and south by William B. Hough Company, Chicago, who have the control of it in the last mentioned territory.

The development of the system covers a period of more than seven years. It evolved from the wooden trough to the wooden trough lined with galvanized iron and finally to the galvanized iron pipe—from the square, flat trough to the "V" trough and finally to the round pipe—and in size it progressed from the square chute, 24 inches wide, to pipe from five inches to twelve inches in diameter—until through experience and application, appliances of general utility and simplicity have been developed consisting of tower, suspended pipe, swinging boom, and universal swivel, as already stated.

The system was originally applied to foundation work, then to walls, beams, girders, and floors. At first only parts of large jobs were attempted, but gradually the system was developed to the stage where it comprised one central mixing plant and a standard equipment of simplified appliances, whereupon entire jobs in all classes of construction were successfully handled from the one central installation.

All problems as to the maximum and minimum angles at which plastic concrete can be run—the practical limits and strengths of booms—the lengths of free ends of swivel pipe—and the best practice as to sizes of pipes for different sizes of stone—have been fully demonstrated in actual construction work and an available fund of data has been formulated which makes it possible for any job, no matter how large and involved, to be laid out in the engineer's office with all questions as to cost of installation, operating, quality and quantity of concrete delivered, predetermined with accuracy and certainty.

The operation of the system briefly is this—

- 1: Mixing of the concrete in any suitable batch mixer—

- 2: Hoisting by means of a skip to an elevated hopper—

- 3: Conveying and distributing to the points of placing by means of suspended pipe operated by cables, booms, and swivels.

Properly mixed concrete, being a semi fluid, and cement acting as a lubricant, the plastic material flows readily due to the action of gravity through the pipes at certain predetermined angles with absolutely no separation or congestion.

While the principle is simple, it is claimed and strongly urged that the general utility of it is of little value without certain of the appliances which have been perfected in the G-Y system and fully covered by three basic patents. The owners of these patents, the Concrete Appliances Company of Los Angeles, California, announce their intention of rigidly enforcing them.

In its present perfected stage the G-Y system is adequate to all classes of construction and to an unlimited variety of architectural design—from simple foundation and tower work to the most complicated dome, column and frieze work, such as found on tall buildings with overhanging cornices. It is adapted to the requirements of small buildings and large buildings, huge squat structures and tall narrow structures—dams, factories and industrial plants, churches and theaters—in brief, all classes and types of concrete construction.

The advantages and economies of the system as claimed are little short of revolutionary in their scope and importance:

It eliminates nearly all the laborers ordinarily required between the mixer and the point of distribution, thus making for economy and speed of construction. An important feature in this connection is that, as the mixed concrete is handled much faster, the mixer can always be operated up to its full capacity.

The system effects a radical reduction in the cost of distributing concrete. A phenomenal record of 40 cubic yards per hour mixed is possible. With this system ten men can mix, hoist, and move more than double as much concrete per day as can be moved by thirty-five men with wheelbarrows or carts. These ten men operating the G-Y system can easily place 300 yards of concrete per day as compared with 160 yards which is considered a high record for thirty-five men under the old-fashioned wheelbarrow or cart system.

The G-Y system saves labor at the mixer, saves labor in tamping, saves labor in handling steel (because the steel is not displaced), saves labor in excavating, and eliminates practically all of the labor in moving the concrete from the mixer to the point of distribution. It prevents congestion and does away entirely with "time killing" due to men getting in each other's way.

The labor cost of mixing, conveying and distributing under favorable conditions has run as low as 19c per cubic yard, and under unfavorable circumstances as high as 35c per cubic yard. The total labor cost, charging up all labor possible to the placing of the concrete including installation of tower and plant, runs from 35 to 50c per cubic yard. These figures in both cases include the royalty for the use of the system.

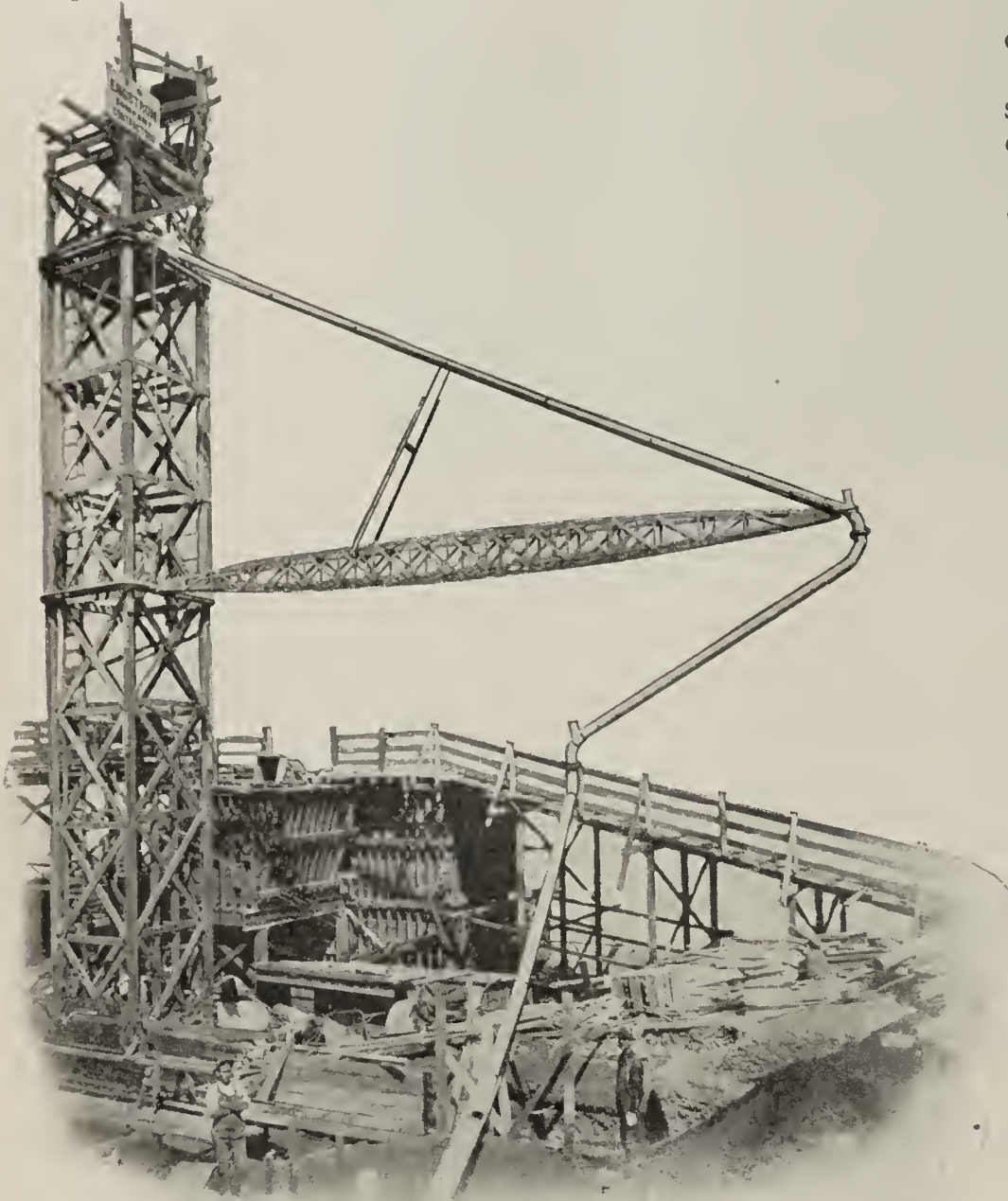
A vital point is that the initial "set" of the concrete is obtained at the exact time and place required and **not enroute from the mixer** as frequently happens in long hauls in carts or barrows.

The concrete is so quickly deposited in placing without any intermediate handling that it takes its initial set simultaneously throughout the entire mass, thus producing a strength and solidity of structure not

possible where carts or barrows are used. The work produced is practically monolithic.

The conglomerate secured is uniform, homogeneous, and plastic, the specific gravity being such that the rocks are held in suspension. The downward flow of the concrete produces a churning motion which obviates all pocketing, and practically no tamping is required.

Contrary to a possible supposition, the concrete arrives at the delivery end of the spout as a better mixture than when it left the mixing machine. There is no separation of the stone because a plastic and not a sloppy or wet concrete is used. The churning motion on the downward flow operates, in itself, as the most efficient mixing action and yields a homogeneous product.



Gravity System in Operation.

Because of the minimum amount of tamping required, the system produces perfect concrete walls whether thick or very thin.

The columns, girders, beams and the entire floor slab of the usual size building can be placed at one pouring of concrete, thus avoiding the jointures in the slabs and beams which are now necessary under present methods. The G-Y System thus makes it possible to produce, in fact, an absolutely monolithic construction.

On floor work the breakage of hollow tile, due to barrows slipping from run-ways, the displacement of steel, and spilling of concrete on steel and run-ways, are overcome and thereby important economics effected.

In mushroom construction, or where there is an excessive amount of steel at certain parts of the structure, by spreading the bars three or four inches, a small

stream of concrete can be poured through the openings, quickly filling the columns.

For the reasons stated a perfect juncture at all critical points is assured in column and beam work.

The ability to handle large quantities of concrete is limited only by the mixing and hoisting capacity, and it has been demonstrated in actual work that the concrete can be placed on a radius of 503 feet from the tower.

The installation of equipment necessary to operate the G-Y system is so slight as not to be an obstacle in any case. Aside from the appliances which are commonly used anyhow in any proper installation for wheelbarrow and cart methods, there are only four appliances necessary to complete the system, namely a galvanized conveyor pipe, a wooden or steel boom, a swivel or flexible joint, and a distribution end for conveyor pipe.

The expense of these appliances is offset by the saving of the cost of wheelbarrows and carts, and the cost of staging for run-ways.

Further economies result from the general utilities of the G-Y system, the boom being used as a derrick for hoisting steel, placing columns, beams, etc., and sometimes to great advantage in excavating.

In order to insure the success of the system by strict adherence to the methods already demonstrated as safe and practicable, while at the same time making it available to the building trades at large, it has been decided to license the use of the appliances on royalties based upon the cubic yards per job; in consideration of which blue prints of the lay-out for the job are furnished together with bill of materials, specifications, etc. As customary, an experienced man is furnished at usual rates to install the system.

The advantages and economies claimed are of such a sweeping nature that if substantiated by the facts, the G-Y system bids fair to completely revolutionize the handling of concrete. In any event, it is certain to challenge the attention and interest of the building trades to an extraordinary degree.



This cut shows the end of the discharge pipe placing the concrete in forms.

THE AMERICAN GYPSUM COMPANY WILL BUILD NEW PLANT.

The American Gypsum Company of Cleveland, O., have purchased considerable land 11 miles from Nashville, Arkansas, on the Memphis, Dallas & Gulf Railway and will erect a plant to cost \$100,000, according to reports. The products of the plant will be plaster of paris, fertilizers and other things.

SURFACE FINISHER FOR CONCRETE WORK.

The ordinary concrete surface, it must be admitted, is anything but pleasing in appearance, being usually a comparatively smooth, lifeless surface of a sombre-grayish color. No matter what cement, sand or aggregate is used, or in what proportion they are mixed, the general appearance of the unfinished form surface is the same, and it is this monotonous sameness in the appearance of concrete work that architects object to so strongly. There may be the greatest difference in the color, shape and texture of the aggregates used in two separate concrete surfaces, yet unless these surfaces are so treated as to bring out and expose the aggregate they will look alike. It is quite difficult to distinguish an ordinary unfinished concrete surface, in which bank gravel is the aggregate, from one in which crushed red granite is used, but the same surfaces, if subjected to any one of a number of different methods of surface treatment, will present a marked and pleasing contrast in appearance.

The object of this paper is to show what can be accomplished in the way of producing pleasing artistic and commercially practical surface finishes for concrete work.

By varying the kind, size and proportions of the aggregates, surface finishes of practically any desired color and texture can be obtained, the possibilities being limited only by the number of different aggregates available and the combinations of same. A great variety of finishes may be produced by using red and black granite and limestone screenings, black and white marble chips and different colored pebbles and sands.

Having decided upon the general color scheme and texture of the desired surface, the first step is the making and treating of small sample surfaces. A limited amount of experimenting with the materials available will always prove profitable. The color and texture of the finished surface depends upon the color, size and proportions of the aggregates used, and the successful reproduction of the desired surface is dependent upon the proper selecting, grading, proportioning and mixing of the materials and the proper placing and finishing of the surface. Upon determining by experimenting the proper size and proportions of aggregates to produce the desired effects and the proper consistency of the mix, adhere strictly to them; that is, take the trouble to measure the materials for each batch of concrete and to gauge them with a measured amount of water. The results obtained will more than justify the extra expense this will entail over the all too prevalent method of measuring material by wheelbarrow loads and adding water with a hose; in fact, uniform results cannot be obtained unless the work is done as pointed out.

The slightest imperfections and irregularities in the form surface are transferred to the concrete, producing unsightly surfaces when left untreated, and a pleasing surface cannot be obtained by a nicety of form construction alone. For brushed surfaces, all that is required of the forms is that the face lagging be kept true to surface and the joints be tight. For surfaces too large to concrete in one day the forms should be so constructed as to permit of the removal of sections of the face form. This can be accomplished by setting the studs or uprights back a few inches from the face lagging and connecting both by means of cleats and wedges. The face forms should also be well oiled to prevent the concrete sticking to the forms. For large areas the introduction of buttresses and panels or the breaking up of the surface by horizontal joints or

courses will add greatly to the appearance, the joints being simply indentations in the surface produced by beveled beads fastened to the forms. It is extremely hard to join two different days' work so that the joint is not perceptible and unsightly, and the breaking up of the surface as indicated will greatly assist in the concreting if care is taken to end and start succeeding day's work at a course or joint.

The facing material should be from 1 to 1½ in. thick, the remaining thickness of the work being composed of ordinary concrete, but the facing and backing must be deposited at the same time so as to make one solid mass, thereby insuring perfect bond. The facing material may be applied to the forms just ahead of the backing, which is placed against and rammed into it, or the backing may be placed first and then pushed back from the form with a spade and the facing material deposited between the backing and the form. Both these methods have been successfully used. A third, and possibly the best method of placing the facing material, consists of the use of what might be called a metal facing form or mold, constructed and used as follows: To short lengths of 3-16-in. iron plates 8 or 10 in. wide and about 6 ft. long, three 1 or 1½-in. angles are riveted, placing an angle at the center of the plate and one about 6 in. from each end. One edge of the plate should be slightly flared to assist in depositing the material and this edge provided with handles. The metal facing plate is placed against the wall form with the handles up and the angles tight against the form. The space between it and the back of the wall is filled with ordinary concrete backing and the 1 or 1½-in. space between the metal form and the face form filled with the facing material. The metal form is drawn almost out and after thoroughly tamping the backing against the facing the process is repeated.

For brushed surfaces the forms must be removed from the work as soon as possible and the concrete surface brushed while still green. It is not possible to state how old the work should be before removing the forms and brushing the surface. This will depend upon a number of conditions, the character of the work, cement aggregate used, consistency of the mixture, and very much upon the weather conditions. As a rule in hot weather the forms can be removed the next day and the surface brushed, but in cold weather the facing form cannot be removed so soon, several days or perhaps a week being required for the concrete to attain the necessary hardness and strength. Care must be taken that the brushing is not done too soon, as little particles of aggregate will be removed, resulting in a pitted, unsightly surface. On the other hand, the longer the surface stands before being brushed, the more brushing it will require to remove the film of material that has flushed to the surface. Brushing should be done just as soon as it can be without removing particles of aggregate. When this can be done can only be determined by experimenting with the particular surface. An ordinary scrubbing brush with stiff palmetto fibers or a metal wire brush will answer for the work.

Two or three days after the brushing the surface should be washed down with a dilute solution of commercial hydrochloric acid, one part acid to two or three parts water. The acid should be applied with an ordinary calcimining brush and the walls thoroughly rubbed while wet with the acid, with a stiff vegetable fiber brush. The acid should not be allowed to remain on the surface for any length of time—no over half an hour—and should be washed off with a hose and clean water. It is important that

the surface be thoroughly washed after the acid treatment, for if it is not it will have a mottled, streaky appearance. A desirable surface may be obtained by simply brushing and washing with a hose and clean water, but the final acid treatment in connection with brushing and washing produces a still better finish as the acid thoroughly cleans the surface of the aggregate, thereby intensifying the color and texture of same.

In this article I have dealt with but one of a number of different methods of surface treatment, plastered, tooled and rubbed concrete surfaces not having been considered, although each of these makes a very acceptable surface. The method of treatment described removes the film of mortar that has flushed to the surface, exposes the aggregate, erases all traces of form markings eliminates the tendency to check and craze, so common on smooth surfaces, and produces a rougher, more artistic surface. The roughness of the surface breaks up the light, the color of the aggregate adds color and life.

FORMS FOR CONCRETE.

In building the Pittsburgh filtration works about 334,000 cu. yd. of concrete were used, this concrete varying from heavy, massive work for machinery foundations to light structural work in walls and floor slabs, and from straight work on walls and floors to the more intricate work on the groined arch vaulting. During the three years active concrete work was in progress many different engineers, superintendents, foremen, carpenters and laborers were affiliated with the work, so that many different ideas were brought together. The experiences were summarized by Mr. J. D. Stevenson, formerly division engineer on the work, in a paper of the above title presented before the Engineers' Society of Western Pennsylvania on September 20, 1910, and printed on page 270 of the "Proceedings" of the society. The notes here presented are taken from that paper. A description of the filtration plant and of the construction methods will be found in the Engineering Record of Dec. 8, 15, 22 and 29, 1906, and Sept. 18, 1909.

Material.—Probably the first thing to consider in the building of forms is the material to use. The choice will be influenced very largely by the number of times the forms may be used. They may be constructed of wood or metal; the latter was used chiefly in conduits and piers or forms having curved or irregular surfaces, while wood was used in all classes of work and almost entirely in walls and structures having plain surfaces.

The kind of lumber is influenced greatly by the cost and supply. White pine lumber is probably the easiest worked and will give the smooth face essential to the best work. The pine will prove very expensive for ordinary work, and spruce, fir, Norway pine and some grades of Southern pine are more commonly used. For braces and uprights the quality is not of great importance; there is a point, however, where an inferior grade of lumber is not economical, as the increased number of times a piece of lumber may be used and the lesser quantity due to greater strength will outweigh the savings in first cost due to inferior quality.

Kiln dried lumber is not best as it will swell too much when wet, and green lumber is not good as it

will not swell sufficiently to make the forms tight. The best quality is a middle grade or partly dry.

When the contract is large, comparable in size to the Pittsburgh filtration works, it will facilitate the work to buy the lumber in the rough and mill it on the site. This will often save delay due to delivery, will save in cost and the waste can be kept at a minimum.

The proper thickness for the sheathing is a question which varies greatly with the contractor. Curved and irregular shaped forms can be made more easily with 1-in. lumber, and where there is much cutting the waste is less. On the other hand, if a form is to be used but once the loss in wrecking thin boards is much greater than will occur with thicker, and more uprights or studs will be necessary to support 1-in. sheathing than 2-in. It was found more satisfactory in the majority of work to use 1½ or 2-in. sheathing in preference to thinner wood.

The thickness and spacing of studs and braces is entirely a question of load to be carried, and can be easily proportioned to the particular piece of work.

Design of Forms.—It is advisable to have the forms and braces designed by a competent man, as often the foreman or carpenter in the field does not have the knowledge or experience necessary. It is often the case that a piece of form work will be overbraced, or by reason of inexperience the bracing will be so arranged as not to secure the maximum results from the minimum labor and material. Frequently, also, the forms are underbraced and give way during filling. All this can be best remedied with a design made by a competent man, which can be done at a small cost.

Where the forms are used but once and wrecked it is advisable to have the joints between boards V-shaped with the vertex toward the concrete, known as a beveled joint, as the boards can be removed much more easily and with less waste due to breakage than if a tongue and groove joint had been used; and if the lumber is not too green the joints will swell shut and be just as tight. For forms used a number of times best results will be had from tongue and groove joints. The tongue and groove tends to make the several boards act more as a unit and the force necessary to break the bond between the concrete and form, which is applied more or less on a single board, will not distort the face of the form as quickly as without this unit action. The alternate swelling and shrinking due to the wetting and drying will not cause the trouble in a tongue and groove joint that would be experienced in a beveled joint.

In the design of forms it is of importance to look to their removal, as upon the speed of removing and the number of times forms can be used with the minimum amount of repairs rests the economy of the design. The forms should be designed in as large sections as can be conveniently handled. In deciding size, the removal of forms will have a greater bearing than the placing, as the removing of forms must largely be done by hand, often in cramped places, while the placing or building will be in the open and can be facilitated by cableway or derrick. It will be found very difficult at times to break the bond between a form and the concrete without damaging the form. Often it was necessary to have as many as 12 men pulling on a block and falls and then the ribs pulled from the sheathing before the bond could be broken.

In forms to be wrecked spikes and nails should be very sparingly used; sufficient nails to hold the form together is all that is required, as the concrete will furnish all the pressure necessary to hold the sheathing

to the studs. It will not then be necessary to use sledges and bars in wrecking, and when the forms are removed the lumber will be in much better shape and can be more economically worked.

The building of forms without nails has been tried. The studs were placed and the sheathing, consisting of 6-in. boards with tongue and groove joints, was placed as the work progressed. The experiment was on conduit and the advantage claimed was easy removal of forms and complete access to all parts during filling. The results showed delay in placing concrete due to waiting on the placing of the sheathing and a rough and very unsatisfactory surface after removal.

It is best to set up the forms completely, nailing just sufficiently to hold in place, and, if advisable, to remove certain parts to facilitate filling; having been once fitted they can easily be replaced.

Support of Forms.—There are a number of methods for supporting the forms from the interior while filling; by means of wooden struts, bolts, concrete struts and wiring. A very satisfactory method is the use of wooden struts and wire; the struts to maintain the proper distance and the wire to tie the forms together. The struts must always be placed where the sheathing is supported by a stud and the wire should loop the stud, then by twisting the wire with a short bar the forms can be drawn tight and held rigidly in place during filling. When the concrete has been placed to the level of the trust it can be removed and the weight of the concrete will then hold the forms apart. In first placing the struts they should be lightly nailed, the wiring will hold them in place, and they will be more easily removed.

On removing the forms the wires should be cut close to the concrete, the ends stove in with a punch and the surface smoothed over. The finishing is one point more or less open to criticism, as it takes considerable care to make a good job. A great advantage in the use of wire, Mr. Stevenson thinks, lies in the fact that a form can be tied down to prevent floating and can be tied and cross-tied at any angle. No. 8 wire will fulfill the requirements of most work.

When the space between forms is so narrow that the removal of the struts becomes a troublesome task, concrete struts can be used. Concrete struts are previously cast and placed in the same manner as wooden, and can either be broken with a tamper when the concrete is placed to the proper level, or if they have been cast with a water stop they can remain in the wall. The greatest difficulty is in preventing a void immediately under the strut. The breaking will do away with this possibility. Care must be exercised to avoid a water channel along the side of the strut.

Bolts are used in several ways. In one method a pair of bolts are screwed into a nut which is placed in the central portion of the concrete and when the concrete has partly set the bolts are removed, the nut being allowed to remain. The space which was occupied by the bolt is filled with grout. Another method is to fit the bolt with threads and a cap on either end. The cap screws on the bolt and extends about 3 in. into the concrete; the cap is removed and the bolt allowed to remain. The latter is much more expensive than the first-mentioned method. In large work involving the using of the same forms a great many times the use of the bolts is very satisfactory and the small nut lost each time is of little value.

The forms, in addition to the interior bracing, should be braced on the outside; this is generally accomplished by bracing to the earth or to adjoining structures. This portion of the form work is probably more neglected than any other. The exterior bracing

must be relied on for holding the form to alignment. Butt bracing is more secure than splices, the salvage will be greater and the cost of reworking the lumber less.

In building a structure in a number of lifts it will often be found advantageous to terminate each lift of forms in a short section, say 3 ft. high. This section, which is tied together by wires and securely held to the concrete by the bond, can be left, upon removing the forms, as a base upon which to build the next lift.

Coating Forms.—Forms are covered or coated to decrease the bond between the form and the concrete and thus permit easy removal or to give the concrete surface a smooth finish. The latter is important in the case of conduits, where the friction loss is a factor.

Covering wooden forms with metal has a number of objections; it is an added expense and does not increase the life, as the metal readily breaks and tears when removing, and if the form is strained in the handling the metal covering makes it harder to put back in shape. The rents, although smoothed down, still have irregularities which will catch in the concrete and the next removing will leave them in far worse shape. If metal is necessary a complete metal form is more economical.

Painting the forms greatly facilitates their removal and also increases the life of the forms and makes them much easier to clean. The pores of the wood and the cracks are filled with the paint and the grout is thus prevented from entering. A satisfactory method, Mr. Stevenson says, is to coat the forms after cleaning with cold-water paint, and after they have been erected give another coat. This is particularly applicable to conduit forms.

Forms were often oiled on the filtration work and for walls and roof vaulting was very satisfactory. Other dressings composed of various proportions and combinations of soap, paraffine, kerosine and similar materials are used, but are more expensive and more troublesome to prepare and apply, and have little advantage over oil or cold-water paint.

Buoyancy of Forms.—The tendency of forms to lift during filling will cause much trouble if not properly cared for. In a wall section which has considerable batter, a hook made of reinforcing steel, imbedded in the foundation offers an arrangement to which to tie the forms, the tie being made with No. 8 wire.

Conduit forms and box forms are often loaded with pig iron, lead or other heavy material. As this is always more or less expensive and troublesome, the contractor is liable to take chances by underloading. Under this same heading comes the rolling of forms, which applies more to conduits and is mostly caused by uneven filling. The best method of preventing this is by care in filling to keep a uniform level on both sides of the barrel.

In trench work where there is sufficient depth the upward or side movement of forms can be cared for by bracing to the sides of the trench.

Joints.—The placing of joints and the method of making joints is generally decided by the engineer and often proper consideration is not given the contractor in making the decision. The location of joints will govern to a large extent the possibility of cracks and thus is a large factor in the design of the work, and it may also greatly affect the cost of the form work and in this way the contractor. Mr. Stevenson points out that a study from both the engineering and constructing point of view as to the effects of placing joints should be carefully made.

In the filtered-water reservoir the location of joints

was made after thorough study. The sides converge at the rate of one span of the arch in width, or 18 ft., in every nine spans in length. By this arrangement one set of forms could be used seven times, or practically the life of the forms. The joints between sections of wall were placed directly over the joints in the floor, joints in the barrel arch over joints in the wall and joints in roof groins were in line with joints in the barrel. Thus all joints were on center of bay lines, although all centers of bays did not have a joint, as often two bays, or 36 ft., were built monolithic. This, Mr. Stevenson states, was the most economical design for the contractor.

The design of a key between monolithic blocks varies a great deal. Some keys are to prevent slipping of one surface on another, while in other places the key is for water tightness. A key similar to a tongue and groove in lumber, the sides being slightly battered, is most generally used; it varies in size with the bulk of the structure. For vertical joints the groove will be constructed in the forms and is generally designated as a depressed key. On horizontal joints it will be found that a raised key, or the tongue, is more easily constructed for the reasons that the forms for it will not float, it is more easily held to a fixed location and removed, and can be cleaned better when placing the next section.

Keys of the tongue and groove type are not necessarily water tight; they only make the path to be traveled by the water longer and change the direction of travel.

For work requiring a large degree of water tightness a sheet of metal will give best results; sheet lead, copper, galvanized iron or similar metal imbedded 3 or 4 in. in monolith, doubled back on itself and extending the same distance into the next monolith. The doubling-back is for the purpose of allowing for movement due to expansion and contraction.

Care while Filling.—In filling forms the platform for mixing or dumping should be independent of the forms. This will prevent a shock caused by dumping. In no case should the concrete be dumped from a bucket directly into the forms, unless a bucket especially adapted to spreading is used, as this is likely to distort the forms and will often affect the uniformity of the finished concrete. By dumping a bucket on the platform the concrete will receive a mixing which will tend to remove any stratification which has occurred in transportation.

Before filling it is advisable to turn a hose on the forms, thoroughly wetting them. This will not only wash the foreign matter from the forms, but will cause them to swell and prevent leakage. During the filling a carpenter should be constantly in attendance calking with cotton or jute any leaks and seeing that the braces are not loosened.

Often trouble will arise in the removing of the struts, especially in thin walls heavily reinforced, as the available room for the removal of the struts is small, and usually the forms and steel are covered with mortar, making a most disagreeable place in work. The struts should be removed as they are reached and careful watch kept so as to remove all.

Removing Forms.—The time for the removal of the forms cannot but be left to the discretion of the engineer, as the time required for concrete to set varies greatly and largely depends on weather conditions and the particular brand of cement used. Also the bulk of the structure will affect the removal. Often in cases of walls and structures requiring treatment of the surfaces to produce a finish it is necessary to remove the forms at the earliest possible date and

while the concrete is green. The question of length of time in case of this nature can only be solved by previous experience.

A schedule of time for removing forms under average conditions on the filtration work was as follows: Floor forms, the following day; pier forms, after the third day; wall forms, after the second day; vaulting forms on reservoir, after 10 days; vaulting forms on filters, after six days; conduit forms varied from the following day to three days.

The work of removing forms is frequently, and unfortunately, placed in the hands of laborers and, as a result, the forms are broken and destroyed to the extent of costly repairs. In taking down forms the bracing or props should never be knocked out and the forms allowed to fall. This is not only liable to damage the forms, but the impact is liable to damage other work. The forms should always be eased down by a cable or other similar method. In roof vaulting, Mr. Stevenson states, the method of cable and drum is very satisfactory. Sledges and bars should be used with the greatest of care, if at all. It will at times be very difficult to break the bond between the concrete and forms and the use of block and falls will be necessary. This will have to be done in a careful manner to prevent the twisting or distortion of the form. It is well to start a form by use of a wooden wedge rather than exert a great force by block and falls.

The forms upon removal should be thoroughly cleaned of all cement. This can be done by scraping and will prove rather costly, but the thoroughness of this cleaning will greatly affect the speed of removal and the surface finish of the concrete in later work, so the additional cost spent in scraping is saved in other ways. It is much easier to remove the concrete which has adhered to the forms immediately upon the removal of the forms and the longer a form stands the harder it will be to thoroughly clean it. As soon as the forms are removed they should be cleaned and any necessary repairs made and the forms piled in some convenient place. The piling, although a small matter, will often cause much trouble; if the forms are carelessly piled, having bearings at points that will allow them to sag, the forms are liable to set to this untrue shape and endless trouble in setting them to line and grades will be experienced.

ARCHED MASONRY DAM AT LAS VEGAS, N. M.

By Charles W. Sherman,* M. Am. Soc. C. E.

The Agua Pura Co., of Las Vegas, N. Mex., the corporation which furnishes the water-supply to that community, is about to undertake the construction of an arched masonry dam. This structure has been designed by Metcalf & Eddy, Consulting Engineers, of Boston, Mass., and has been computed as a pure arch, without allowance for such additional stability as the dam may have acting as a wall. The design of this structure is in many respects somewhat different from ordinary American practice, although, as far as the dam itself is concerned, it is in general similar to a number of dams which have been built in New South Wales, Australia, within the last 15 years, and which are briefly described in an article by Mr. L. A. B. Wade in *Engineering News*, May 19, 1910, p. 588.

As is shown by the cross section, Fig 2, this dam.

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with a maximum height of 50 ft., will have a thickness of $15\frac{1}{2}$ ft. at the base, corresponding to a pressure in the arch of 350 lbs. per sq. in.

Preliminary Considerations.

In order to indicate the reasons for the construction of this dam and the adoption of the type and of many of the details it is desirable first to outline the manner in which the water-supply is obtained and stored, and to describe some of the local conditions affecting the problem.

Las Vegas is a community with a population of something less than 4,000 in 1900, and which is estimated at something like 10,000 at the present time. It is situated in the northeastern part of New Mexico, on the main line of the Atchison, Topeka and Santa Fe R. R., at an elevation of about 6,500 ft. above sea level. The town is divided into two parts by Gallinas Creek, and from this stream the water-supply is taken at a point above Hot Springs, some six miles above the city proper. In this locality the Agua Pura Co., has built nine dams, which have been especially constructed for impounding water during the winter, for the purpose of harvesting the ice, the company handling the ice-supply as well as the water-supply of the locality, and selling large quantities of ice to the railroad company. The water for the supply of the city is taken from the stream just above Dam No. 8, and conducted, in a wooden flume, to a small reservoir known as the "settler," in which some clarification by subsidence is obtained; the pipe line leading to the distributing reservoir and the city starts from this "settler." Most of this pipe line is 12 ins. in diameter, and it has a length of about five miles.

The rainfall in this vicinity is about 18.66 ins. per annum, this being the average for the 18 years 1889 and 1893 to 1909 inclusive. The maximum yearly rainfall during this period was 24.66 ins. There are very few records of watershed yield in this vicinity, and these are of a somewhat unsatisfactory character. The 90 sq. mi. of drainage area above the intake have usually given a sufficient quantity of water for the supply of the city, but there has been one period of several months when there was a shortage, and with the growth of the city and the increasing water consumption, it is evident that such periods of shortage will be increasingly numerous in the future unless adequate storage is provided to make the yield of the wet months available for use in dry times.

Still more pressing, at the present moment, is the question of quality of water. During a large portion of the year the water is clear and satisfactory, but at other times it is rendered decidedly muddy by the soil washed into it in times of rain.

Two methods of obviating this difficulty were considered by Mr. Harrison P. Eddy, who reported upon this and sundry other improvements to the property of the company, early in the present year. He decided in favor of storage and subsidence, instead of mechanical filtration, because it seemed probable that the quality of the water obtained thereby would be nearly, if not quite, as good as by filtration, and the advantage of increasing the quantity of water available, which would result from a storage reservoir, would not be obtained if the filtration system were adopted. Moreover, it would be possible, at any future time, to put in filters in addition to the storage reservoir.

The best available site for a storage reservoir was found to be the lime canyon just below Hot Springs and a little more than a quarter of a mile distant from the pipe line. It would be possible, by the construction of a suitable dam, less than 500 ft. long, to

store water to a depth of 95 ft. in this canyon, which would correspond to a storage of approximately 380,000,000 gals. Mr. Eddy concluded that not less than 50,000,000 gals. storage should be provided at the present time, which could be obtained by a dam 50 ft. in height, and this the company has decided to construct at once.

There is a small watershed tributary to the lime canyon, but no stream flowing through it, except immediately after rains. It seems to be desirable to divert this water from the proposed reservoir, because it is muddy after rains. It was therefore recommended that a dike be constructed above the limits of the proposed reservoir, and also a diversion ditch just above the water line, by which the natural drainage of the canyon should be diverted around the basin to a point below the dam. The construction of this ditch, however, has been postponed, and is not included in the contract for the structure, recently awarded.

The basin is at such an elevation that when filled to a 95-ft. depth the water level will be substantially at the level of the "settler." It will therefore be possible to fill the 50-ft. storage reservoir by gravity from the existing pipe line, and it is planned to lay a 16-in. branch from the present 12-in. main to the gate-house at the dam. Water will be either admitted to or drawn from the reservoir through this pipe. The 95-ft. reservoir will require the construction of a high level conduit from a point further up the stream.

Studies and approximate estimates of cost of three different types of dam at the outlet of the canyon were made: (1), a straight masonry dam with a gravity section, (2), a curved masonry dam with an arched section, and (3), a hollow reinforced concrete dam of the Ambursen type.

It was soon found that the Ambursen dam, under the peculiar conditions, could not be constructed as cheaply as either of the other types, on account of the probability of a future increase in the height of the dam. Either a straight or a curved masonry dam could be erected at the present time, of the cross-section required for the height to which it is now built, and can subsequently be raised to a greater height and at the same time increased in thickness, whereas a dam of the Ambursen type must probably, if it is hereafter to be raised, have its lower parts built of the full ultimate thickness.

The mouth of the canyon is narrow, with comparatively steep sides, and with rock exposed at the surface of the ground over about one-half of the site of the dam, and with every indication that rock is but a short distance below the surface where not exposed. The contour of the surface is such as to be well adapted for the abutments of an arched dam, and approximate estimates showed that such a structure would require less than two-thirds as much masonry as a straight dam with a gravity section. After several trials it was found possible to lay out an arched dam with a radius of 250 ft. for the up-stream face, in which the curve would be approximately normal to the direction of the contour. Designs were accordingly completed on this basis.

The rock in this vicinity is a very hard and close-grained sandstone. It seemed quite possible that in excavating for the foundation of the dam and for the diversion ditch, rock might be taken out that would be entirely suitable for first class rubble construction, and it is of course entirely possible to obtain suitable stone for concrete by crushing this rock. As there was no reason why either a rubble or concrete dam would not prove entirely satisfactory,

alternate designs were prepared, and bids were asked upon either rubble or concrete—the only difference in the plans being that near the top of the dam the cross-section was made thicker for the dam built of rubble, in order to lessen the probability of joints extending nearly through the structure, with consequent likelihood of leakage. After the bids were examined it was decided to use the concrete section, and the contract was then awarded on that basis, after the design shown in the accompanying figures.

STATIONARY AND PORTABLE LIMESTONE CRUSHER.

The Williams Patent Crusher & Pulverizer Company, with general sales offices at 545 Old Colony Building, Chicago, has recently made a new departure in the construction of machinery for the preparing of limestone for land fertilizer. It has installed no less than fifteen plants in the last year for this purpose. The agricultural colleges throughout the United States are educating the farmer to the fact that limestone when properly pulverized can be used as a fertilizer at a low cost.

This has opened a new field for the quarries that have been throwing away their screenings. A great many quarries in the vicinity of steel mills who make nothing but a fluxing stone are compelled to pay the railroads good money to haul this stone away and dump it. This same limestone in the form of screenings can be properly pulverized at a small cost and sold to the farmer at a very good margin to the quarry operator.

USING THE GRAVITY SYSTEM.

The gravity system for pouring concrete is being used in practically all the important concrete jobs now under way on the Pacific Coast.

The new Union League Club building in Los Angeles will be nine stories and the F. O. Engstrum Company is using the gravity system to facilitate greater speed, as it is desired to have the building ready for occupancy next March.

In the construction of a five-story reinforced apartment house for the Rampart Investment Company of Los Angeles, Architect Paul C. Pope has specified the gravity system of construction and the same system will be used in pouring the concrete for San Jose's new \$150,000 hotel. William B. Hough Company, Chicago, Ill., are the western agents for this system for pouring concrete.

Canadian Cement Show.

The Canadian Cement and Concrete Association announces that the Convention and Cement Show planned for January will be held several months later, namely

**March 6-11 in the St. Lawrence
Arena, Toronto.**

MCCORMICK WATERPROOFING COMPOUND USED.

When the LaSalle street tunnel is completed, which probably will be some time next year, it will contain 35,000 cubic yards of concrete. It will take 50,000 barrels of Marquette Portland cement to complete this work. Somewhere near 8,000 barrels of this cement have been used up to the present time, and waterproofed with the McCormick Waterproofing Compound. Nearly 8,000 pounds of this waterproofing compound so far has been mixed with the concrete to attain the desired effect. The proportion of the waterproofing compound of the McCormick Waterproof Portland Cement Co. of St. Louis, Mo., mixed with concrete is $10\frac{1}{2}$ pounds to each barrel of cement or 15 pounds to the cubic yard. It is estimated that fully 55,000 pounds of the McCormick Waterproofing Compound will be used in the concrete applied in the tunnel. The railway company's chemist, after a thorough test covering a period of three weeks, found it satisfactory and the division engineers of the Chicago Railways Company decided upon its use. Work upon the tunnel is progressing satisfactorily and it is expected that it will be completed some time next year. While the M. H. McGovern Company, general contractors, have pushed the work with great energy, unavoidable delays have occurred and likely may occur before completion, which makes it difficult to state the exact date of completion. The Chicago Railways Company is rebuilding the LaSalle street tunnel and paying for it.

CEMENT TILE MACHINERY NOT AT NEW YORK.

In a recent communication received from the Cement Tile Machinery Company, of Waterloo, Iowa, they advise us that owing to various reasons they were unable to demonstrate their machinery in the space allotted to them at the New York Cement Show.

They beg to advise, however, that they will occupy spaces No. 92 and No. 93 in the Coliseum at the Chicago Cement Show, and the well known Schenk Cement Drain Tile Machine. Perfection Concrete Mixer and their Four Way Block Machine, along with various other machines included in their S. & S. Line will be on exhibition.

The Cement Tile Machinery Company usually have an adequate supply of intelligent Representatives on hand at all exhibitions and we know a visitor at their booth will be treated with utmost courtesy, and we are sure he will obtain much useful information relative to the various machines in this line.

WASHING COAL.

The **Story of Two Coal Washeries** is the title of an illustrated pamphlet issued by the Link-Belt Co. of Chicago, who are pioneers, in this country, in the modern methods of treating and handling coal.

ADVICE ON CONCRETE CONSTRUCTION.

Attention is called to the advertisement of G. O. Sanders of 89 Gainsboro St., Boston, Mass., on page 40, who was formerly of the firm of McLaughlin & Sanders Construction Co., 38 Park Row, New York City. He is an old and experienced hand at the business and those wanting information in this line would do well to consult him.

MONOLITHIC CONCRETE HOUSES.

Probably the most interesting innovation in concrete construction is the building of two hundred and fifty modern residences, all of which are of concrete construction throughout. The houses are being erected for the American Tin Plate Co., which is now building a \$3,000,000.00 plant at Gary, Ind., to employ 4,000 men. The houses are being erected just north of Fifth Ave., one of the leading business streets. The method of construction is along the same lines as perfected by Thomas A. Edison. While the Edison idea has been discussed for several years and improvements made, no definite move has been made to carry out the scheme on a large scale. But the American Tin Plate Co., believing that the concrete house is the most practical modern dwelling, has perfected a plan whereby it will erect hundreds of houses of varying styles of architecture. The houses now being erected at Gary will cost from \$2,500.00 to \$10,000.00, the average being about \$4,500.00.

The process of construction is by erecting steel forms into which the concrete is poured from the mixers. These forms were manufactured by the Reichert Mfg. Co., Milwaukee, Wis. After the basement walls are in place, the walls of the first story and the second floor are poured and after the concrete has set sufficiently, the steel forms are removed and the second story is poured. Everything is of concrete to the smallest detail. The door and window frames, chimneys, floors, partitions, roof, gutters, cornices, steps and all ornamentations are of concrete. Some of the roofs will be of concrete entirely, while others will have the exposed surface of tiling. The style of architecture will vary so as to insure an absence of monotony.

The manufacture of the steel frames will be a costly item at first, but by the erection of several hundred houses at one time and the purchase of materials in large quantities, the cost is greatly reduced. But as in all other work of the United States Steel Corporation at Gary, the best is sought regardless of cost; and for this reason concrete is depended upon wherever its use is possible.

Besides the two hundred and fifty houses being erected by the Tin Plate Co., three hundred are under way for the American Bridge Co., several hundred will be needed for the skilled mechanics of the American Locomotive Works; seven hundred have already been completed by the Indiana Steel Co., and hundreds of flats and residences have been erected this year by private parties. It is estimated that \$10,000,000.00 will have been spent this year in building operations in Gary; the greater part of which are entirely or in part of concrete construction.

Probably the finest example of concrete construction, especially for exterior treatment, is that of the new Union Station, which is located on Broadway.

OLD CEMENT SEWER WELL CONSTRUCTED

Workmen from the City Engineer's office, Reno, Nev., recently dug up an old cement sewer pipe which was laid twenty-six years ago. The pipe was as hard as iron and rang like a piece of metal when struck with a rock. It took the hardest sort of blows to break it. City Engineer Mann declares that this proves conclusively the usefulness of cement for underground work, and that it is one of the most perfect concrete specimens he has ever seen.

EARLY DEVELOPMENT OF REINFORCED CONCRETE.

In the introductory lecture to a course which will be given this year in the School of Building of the London, England, County Council, Mr. H. Kempton Dyson, secretary of the Concrete Institute, sketched the history and development of reinforced concrete, in the course of which he mentioned some primitive and early methods of reinforcing masonry.

He called attention to the construction used in the roof of a Roman tomb built on the Via Appia about 100 B. C., or earlier. It has been found to consist of a slab of lime concrete in which bronze rods were placed crossing each other to form a reinforcing latticework. The Romans also strengthened their masonry work by timber and tiles. In China, too, efforts were made to strengthen masonry by embedding foreign materials in it. At one point it has been found that the Great Wall of China, on a bad subsoil, was built on a kind of concrete raft, in which timber, reeds and rushes were embedded. In the Middle Ages, Mr. Dyson stated, timber was frequently employed to reinforce rubble-concrete walls.

The first suggestion of an idea of reinforcing concrete in modern times, according to Mr. Dyson, seems to have been a statement in J. C. London's "Encyclopædia of Cottage, Farm and Village Architecture," published in 1830, in which it was suggested that flat roofs might be constructed of latticework of iron tie-rods thickly embedded in cement and cased with flat tiles. About 1840 two systems of floor construction were employed in Paris, known as the Vaux and Thuasne systems; the former consisted of round rods, closely spaced, hooked over flat wrought-iron bars placed on the edge some distance apart and embedded in a slab of plaster-of-paris concrete; while the latter employed small iron joists with hangers or stirrups placed over them, in which round rods were suspended, placed in holes in the stirrups. Plaster of paris was, however not a proper cement to be employed, as it caused the embedded iron to rust, and probably the reason reinforced concrete did not arrive sooner was that the world was waiting for a suitable cement—it needed Portland cement, which was invented in 1824, but was not manufactured to any extent until some years later.

The first real inventor of reinforced concrete in the modern sense seems to have been W. B. Wilkinson, a plasterer, of Newcastle-on-Tyne, who took out a patent for floors and beams of the same in 1854. Mr. François Coignet, a Paris contractor, took out a patent in 1855 for reinforcing slabs with a network of iron rods, and a M. Labot, another French contractor, proposed the construction of ships by means of concrete with an embedded skeleton of wire, and he constructed a punt of the kind which was shown at the Paris Exhibition of 1853, and is still in service in a pond at Miravel, where he resided. Among those credited by Mr. Dyson with the development of the art are Frederick Ransome, Monier, Hyatt, who made a great many tests on reinforced concrete beams and worked out formulas for their strength; W. E. Ward, who erected a building in New York in 1875 containing reinforced walls, floor-beams and roof; E. L. Ransome and Hennebique.

CHICAGO CEMENT SHOW

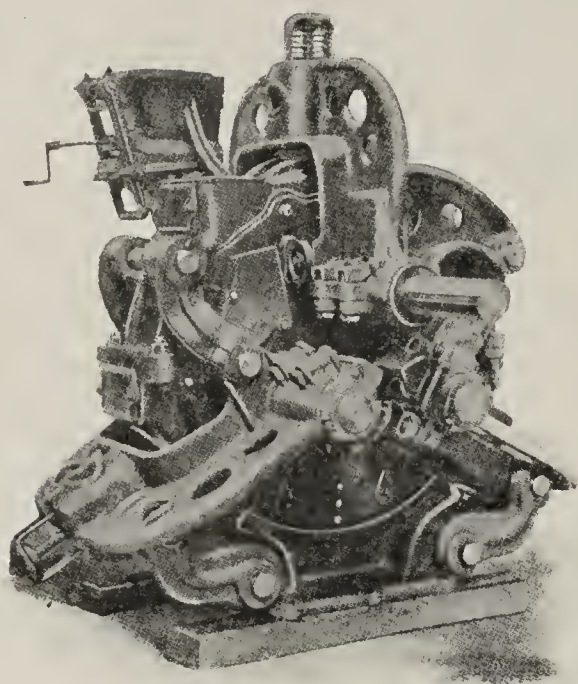
FEBRUARY 17--23

1911

THE MAXECON MILL.

A most economical and efficient grinding machine, the Maxecon mill, which is shown herewith is manufactured by the Kent Mill Company, of 170 Broadway, New York. It is proven a great success and surpasses the record long held by the Kent mill for large capacity, little horsepower and low repairs, demonstrated during its many years of use by some of the largest users of grinding machinery in the United States and Europe. In grinding principles the Maxecon is identical with the Kent. An exterior and interior view of the mill is shown, from which it will be noted that the grinding parts consist of three rolls, each carried on a shaft supported at both ends equally in bearings carried by a solid yoke, which swings in perfect parallelism. No overhung shaft supported at one end only. A grinding ring is supported by the three convexed rolls which assume a central position within it and are held up to the inner concave face of the ring by springs under each yoke capable of maintaining a pressure of 20,000 lbs. between the faces of the ring and rolls.

The material fed to the mill falls on the inner concave surface of the ring. The upper roll is driven and sets the ring in motion at such a speed that sufficient centrifugal force is developed to hold the material on the inner face of the ring in a layer about an inch deep, so that as the ring revolves the material is car-



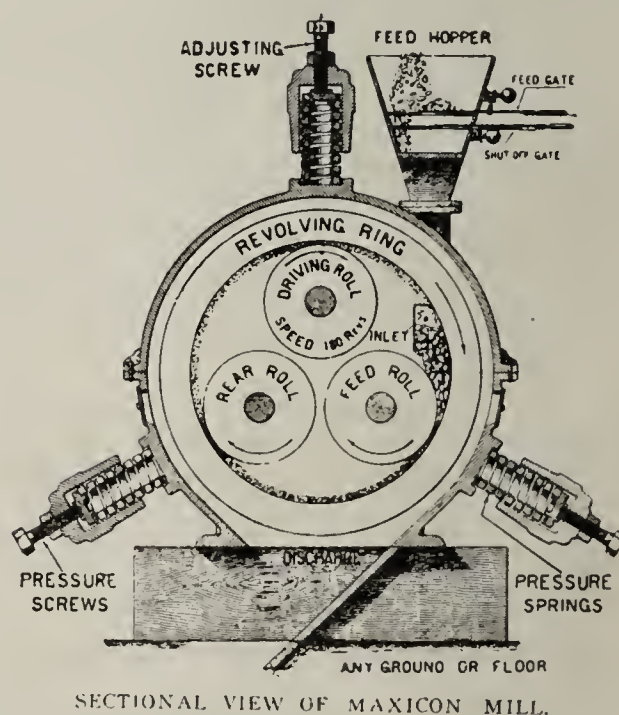
The Maxecon Mill.

ried with it and passes under the rolls successively until it is crushed down and squeezed over the edge of the ring, whereupon it falls to the discharge. The free running ring has a slight side to side motion as well as the forward revolving motion. This accounts for the enormous amount of impalpable powder produced by it. The grinding principle explains the economy in repairs effected by the Kent and Maxecon pulverizers, because of this layer of material being ground, only the outer surfaces come into contact with the grinding parts, the inner particles of the layer grinding and abrading on themselves so that in reality only about 25 per cent of the material ground in these mills ever touches the grinding parts, making, the manufacturer's claim, at least 50 per cent less repairs than any other grinders of the same output.

The Maxecon mill has incorporated in it all the good qualities of the Kent mill and every improvement suggested by the long experience of the man-

ufacturers and their customers has been included. On account of the most efficient and economical results reported by users the mill was named "Maxecon" from "MAXimum ECONomy." Repeated orders from the Universal Portland Cement Co., who are now using 46 Maxecon in their plants at South Chicago, Ill., and Universal, Pa., as well as orders from many other cement plants, have proven the Maxecon operates most efficiently and satisfactorily under the hardest conditions. Some pointed advantages of the Maxecon mill are: Heavy construction makes it break-proof and steady; solid yokes insure bearing alignment and avoid heating; removable bearing sleeves, which are oiled from large oil wells holding a day's oil, and which can be filled while running, permit easy and cheap renewal of bearings; leak-proof dust guards make a dustless mill, and removable feed chutes, easily renewed, prevent wear. Open sides give quick access and save labor. Heavy springs increase crushing power and insure fine grinding.

The Maxecon mill is particularly recommended as a preliminary grinder for tube mills. Results obtained show that one Maxecon ground 52 barrels of cement clinker per hour to a fineness of 20 mesh, with less than 25 horsepower. Assuming, however, that 40 barrels per hour be taken as a safe average, at that one Maxecon could easily feed two tube mills, and take the place of two or in some cases three ball mills. A large saving in horsepower consumption and repairs is indicated by using Maxecon mills in place of ball mills. As a finisher results obtained show that the Maxecon mill ground: 5 tons per hour of limestone 98 per cent 100 mesh, 92 per cent 200 mesh; 15 barrels per hour of clinker 98 per cent 100 mesh, 89 per cent 200 mesh. On coal the capacity is usually estimated at 3 or 4 tons per hour to 95 per cent 100 mesh. From these results it is apparent that the usual estimated capacity for each Maxecon as 10 to 12 barrels per hour of finished cement, or 3 to 4 tons per hour of 98 per cent 100 mesh limestone are very conservative and may be relied upon. On any of the above work the horsepower usually required by the Maxecon mill is less than 20 and the repairs may be figured at less than 1 cent per barrel of finished cement ground.



Chicago Cement Show

February 17--23

1911

NEW CEMENT MILLS.

The Toltec Portland Cement Company, a concern which is controlled by the Speed interests of Louisville, Ky., has just completed a half million dollar plant at Toltec, Hidalgo, Mexico. The plant is in charge of W. E. Burk of Louisville, who has superintended its construction and will manage its operation.

The United States Gypsum Company, general offices, Chicago, was granted a permit to erect a \$15,000 factory in Milwaukee. The factory will be of brick and stone.

A cement factory is to be established at Lost City, Okla. The decision to erect the factory was arrived at in a conference between officers of the Tulsa Commercial Club of Tulsa, Okla., and L. F. Barnes, of Humboldt, Kans. Mr. Barnes agreed to build the plant. It will cost a million and a quarter dollars and will furnish employment for at least 200 men.

The new fire-proof mill the United States Gypsum Company is erecting in Fort Dodge, Iowa, will be put in operation the middle of December. The total cost will be \$400,000 and the capacity of the plant will be 1,000 tons daily.

J. G. White & Co., 43 Exchange Place, New York City, are preparing plans for a \$1,000,000 plant for the Michigan Limestone & Chemical Co., 43 Exchange Place, New York, N. Y.

It is rumored that another cement factory will be erected during the coming year, at Corrine, Utah. The Ogden Portland Cement Company, Ogden, Utah, will be heavily interested in the new enterprise, if the plans of the company mature.

It is understood that the Dexter Portland Cement

Company which operates a Portland cement plant at Nazareth, Pa., has obtained an option on a tract of white clay near Saylorsburg and will engage in the manufacture of white cement.

The Arkansas City Portland Cement Company, the first cement company to set up its headquarters in Wichita, Kans., has 75 men employed in rushing the construction of its Portland cement plant at Arkansas City. It is expected by the authorities of the company that the plant will be completed by next April.

The contract for the construction of the mammoth cement plant of the Golden State Portland Cement company at Oro Grande, Cal., has been let to the Union Iron Works.

Arrangements have been perfected through the efforts of C. C. Crabtree, 620 St. Joe St., Rapid City, S. Dak., for the organization of a Portland cement company at Rapid City, which will operate on extensive gypsum beds, west of here. The company is to be capitalized at \$3,500,000. It will control 1,180 acres and the plant will have a daily capacity of 4,000 barrels.

Dr. G. B. Crowe, Brown-Marx Bldg., Birmingham, Ala., is interested in the establishment of a cement plant at Tuscaloosa, Ala.

CEMENT MILL NEWS.

It is reported that the Bonner Springs Cement Plant of Bonner Springs, Kans., has changed hands. New machinery will be purchased and installed.

Mr. Frederick H. Lewis has resigned his position as manager of the Standard Portland Cement Company at Leeds, Ala. He still continues as vice-president.



Indianapolis, Ind.,
Aug. 12th, 1910.

"We are using **KOPPEL CARS** and **PORTABLE TRACKS** and find them very servicable. We use them for excavating, handling sand and gravel to mixers, also for transporting cement and brick; in fact, for anything that can be transported in such cars where the building covers considerable area. *This equipment pays for itself on one large job.* I would recommend to anyone the use of this equipment on large work, or where the work covers considerable ground."

BEDFORD STONE & CONSTRUCTION CO.

E. C. Strathmann, Gen. Supt.

ORENSTEIN-ARTHUR KOPPEL CO.
Pittsburgh, Pa.

Branch Offices:

New York

Chicago

Baltimore

Philadelphia

Boston

San Francisco

Denver

Portland, Ore.

Los Angeles, Cal.



The contract for the steel construction work for the Nebraska Portland Cement Company of Superior, Neb., has been let to the Kansas City Construction Company, Kansas City, Mo. Work will commence at once.

One of the most massive and one of the tallest chimneys in Iowa will be erected by the Lehigh Portland Cement Company, which company is building a \$3,000,000 plant here. The chimney will be 210 feet high. The base will be 25 feet in diameter, with the smoke flue 16 feet 4 inches in diameter at the base and 11 feet 5 inches at the top.

The Piedmont Portland Cement & Lime Company of Aragon, Ga., is to have its headquarters in Atlanta. W. H. Davis, general manager of the company, has moved here. The office of the company are to be in the Chandler Bldg. The Piedmont company, which manufactures a high grade cement, will soon have a capacity of 1,000 barrels a day. The enlarged plant will be in operation by December 1st.

The Colorado Portland Cement Company of Portland, Colo., intends making improvements to the plant which will cost about \$200,000.

The general offices of the Nebraska Portland Cement Company will be in Omaha, Neb. Quarters have been leased in the City National Bank Bldg. H. G. Calkins, general manager of the company, will be in charge of the office. The plant of the company is located at Superior, Neb.

Contracts to furnish all of the hundreds of tons of cement to be used in the construction of the new Seventh Street viaduct in Des Moines, was awarded to the Iowa Portland Cement Company of Des Moines, Iowa. The plant of this concern, is one of the largest manufacturing concerns in the state.

Fire destroyed the plant of the United States Gypsum Company at Alabaster, Michigan, recently, at a loss of \$125,000. Mr. Robinson, manager of the company, says a new plant will be running again within six months. The mill has a daily capacity of over 3,000 barrels of gypsum.

Fire destroyed the big warehouse of the Peerless Portland Cement Company of Union City, Mich. The warehouse was totally consumed, together with 20,000 barrels of manufactured cement.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.

The Seventh Annual Convention of the Northwestern Cement Products Association will be held in the city of Minneapolis on February 28 and March 1, 1911.

On account of not being able to secure a suitable building no attempt will be made to hold a Cement Show this year, but it is hoped that the new Coliseum will be ready by next year.

A number of strong papers are being arranged for such as will bring out discussions. These will be on varied subjects so as to be of interest to every one.

The West Hotel has been selected as headquarters and the meetings will be held in the large assembly room on the parlor floor. There are a limited number of rooms on this floor and the next which can be rented for exhibit purposes. Anyone desiring space had better write the Hotel promptly as there are only a very few suitable rooms.

The Secretary is after a record attendance this year and hopes to have a membership of five hundred of the best contractors, block and tile manufacturers, architects and engineers in the Northwest.

Will You Let Us Send You FREE a New HAND BOOK on Concrete Brick and Block Making?

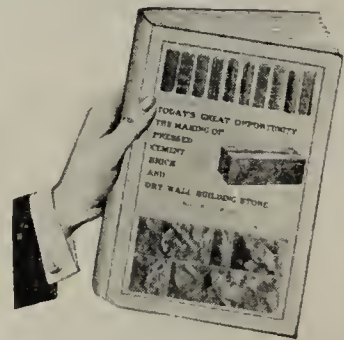
We do not mean a machinery catalog but a **Real, Standard Text Book** on concrete. This new **Hand Book** is right up to the minute and just comes from the press with the latest information on the following subjects and many others:

- | | |
|--------------------------------------|---|
| —The field for concrete | —Ways of making product |
| —Selecting materials | —Various building systems |
| —How to proportion materials | —Forming the product |
| —How to cure product | —Steam curing |
| —Plant arrangement | —A waterproof building system fully illustrated |
| —How to estimate | —Weights of materials |
| —Comparative tests | —Hints on selling |
| —Table of compression working values | —Profits in concrete |

It has cost a lot of money and time to gather this valuable information and while we should sell this book for no small sum, we are even asking if we may mail it to you **Absolutely Free**. There is data in it which will make you keep it for years. You would not be without it.

Just your name and address mailed us will bring you **Free** this valuable **Hand Book** on concrete and we know that you would not sell it back to us for quite a sum if you could not get another copy. The edition is limited so you had better send your name in right away.

Here is another valuable concrete book which you need and we will send a copy of it free with the **Hand Book** on concrete. You need this book because you should know about our latest improved **Combination Helm Presses** equipped for making **Dry Wall** blocks and pressed brick on the one machine. These presses are built in different sizes and for hand and power operation. Do not fail to investigate the **Helm Dry Wall** building system. This system will get you the most business because it saves money for the builder. It saves the cost of furring and lathing and makes the building more fireproof while it is absolutely waterproof.



Every concrete man should have this catalog and no one can afford to start new in business without it. By all means get this catalog and this new **Hand Book** on concrete for you are surely interested in the sixteen subjects which are fully covered in it. You need these books simply to be fully posted if for no other reason.

Just send the coupon today—right now—while you think of it. Get these two valuable books free and without obligation on your part. Send the coupon now.



Helm Brick Machine Co.

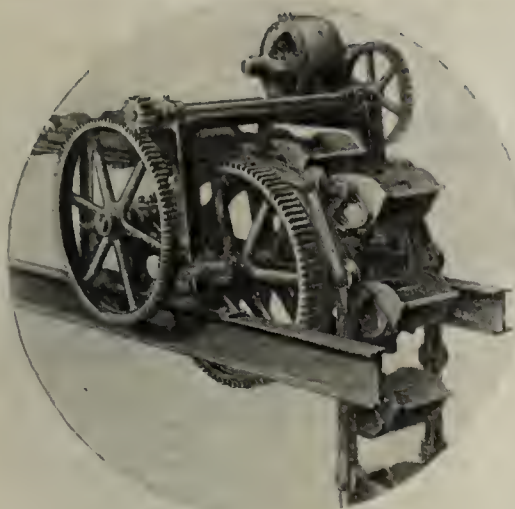
311 BANK BUILDING
TRAVERSE CITY, MICH.

HELM
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Machine Co.,
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Please send me **Free**
the two books advertised
in Cement & Eng. News.

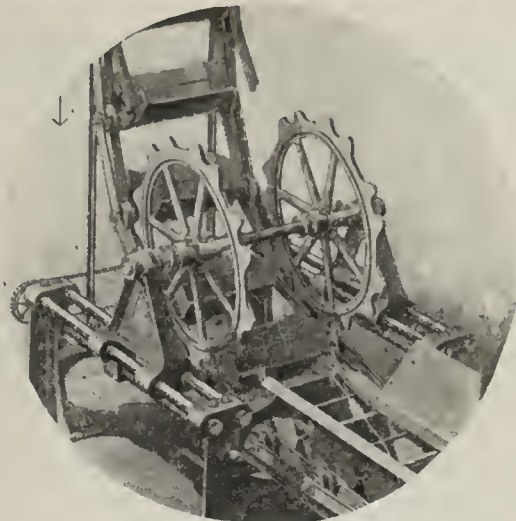
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Upper Turn

PECK CARRIER

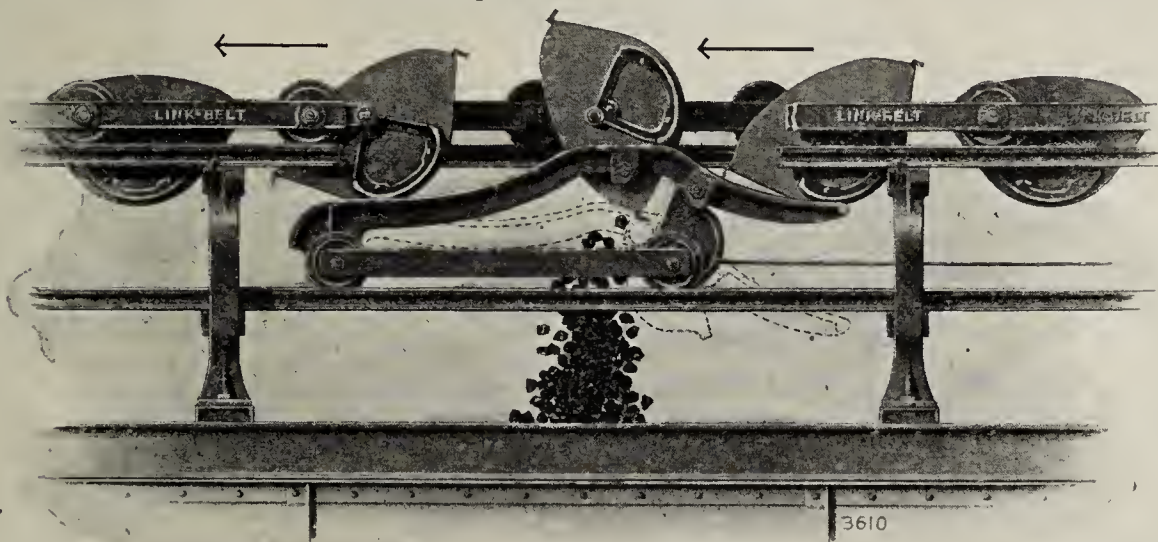


Lower Turn

THE RECOGNIZED STANDARD CONVEYOR
FOR

Cement, Crushed Rock, Hot and
Cold Clinker, Coal, Etc.

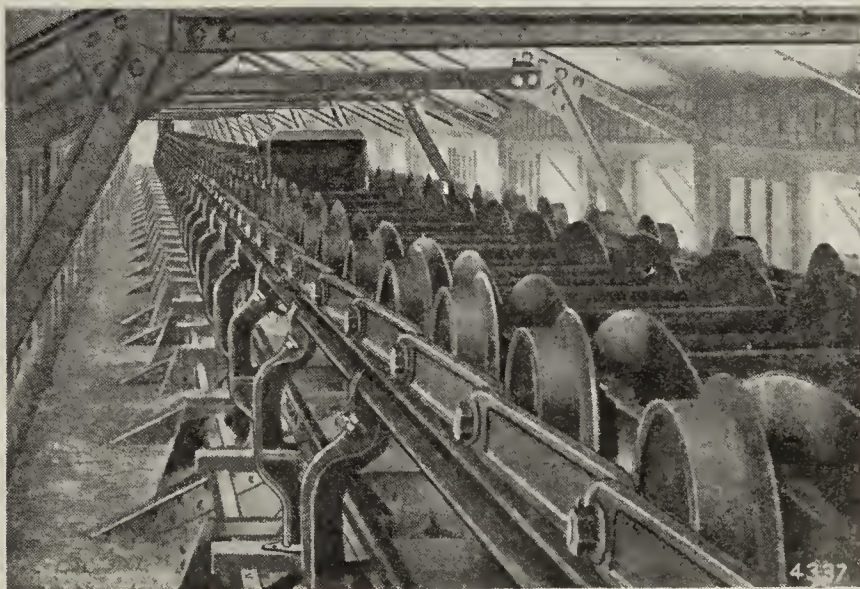
Full explanation in Book No. 81



Movable Dumpers for effecting discharge of buckets on horizontal runs.
Dumpers are also made stationary, when required.



Bridge support for PECK CARRIER over storage area.



Horizontal travel of PECK CARRIER on T-rails. Tilted bucket in emptying position.

LINK-BELT COMPANY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

NEW YORK, 299 Broadway
PITTSBURGH, 1501-2 Park Building
ST. LOUIS, Central National Bank Bldg.
BUFFALO, 601 Ellcott Square

SAN FRANCISCO, Eby Machinery Co.

SEATTLE, 439-440 New York Block
BOSTON, 84 State St.
DENVER, Lindrooth, Shubart & Co.
NEW ORLEANS, Wilmot Mch. Co.

NOTE. --- We have Reserved Space No. 109 at the Chicago Cement Show, Feb. 17-23

PAINTS FOR CONCRETE.

By Ernest F. Burchard.

The use of cement concrete for structural purposes has already become world-wide, and it is increasing at a rapid rate. Heretofore little attention has been paid to coatings for concrete. Enough time has now elapsed to show that cement concrete alone is not as durable as might be wished, partly because it is not wholly waterproof and partly because the cement either contains free lime or develops free lime within itself after setting. Furthermore, concrete in order to compete with other structural materials has had to be economically handled and roughly finished, and its resulting unsightly appearance has detracted from its desirability. It is therefore clear that there is great necessity for both protective and decorative coatings for concrete. The problem of waterproofing concrete is being studied from several standpoints besides that of applying protective coatings. For instance, the endeavor to reduce the voids in concrete to a minimum, as well as to obtain uniformly finely ground cement and to eliminate the tendency of the cement to form free lime in setting, are all absolutely necessary steps in the production of a waterproofed concrete and are the special business of the cement manufacturer and engineer of construction to work out.

Much experimental work is under way with regard to the waterproofing concrete by means of the addition of various foreign substances in small quantities to the aggregate. Some of these materials are of mineral composition and others are organic. Many compounds are now on the market, but the composition of most of them is not published. Some analyses have been made recently on a series of compounds widely advertised for use in waterproofing, strengthening, or decorating concrete. Among the materials contained were stearic acid compounds, gums, waxes, soaps, mineral chlorides, inert pigments, and asphalt derivatives. Much interesting information is given regarding the composition of such compounds, although the names of the particular compounds are not given. The possibility of ultimate deleterious effects on concrete from the use of these internal waterproofing materials is a subject for joint study by engineers and paint chemists. In addition to proving the advantages of such materials as water excluders, it should be determined whether they may corrode the steel used in reinforcing concrete or whether they may affect the set and tensile strength of the cement itself.

It is particularly the province of the paint chemists to study the subject of paint coatings for concrete. Oil coatings have been found to be badly affected by the free lime present, which causes saponification and subsequent solution of the saponified coating. The porosity of cement or concrete surfaces causes an absorption or suction effect that renders it necessary to apply to a given area three or four times as much paint as would cover an equivalent area of wood. Two very important lines of investigation are therefore suggested—the neutralization of the free lime in the cement and concrete and the proper filling and treatment of the pores of the concrete—in order to prevent the suction of any paint that may be applied later.

BOOK NOTICE.

A new handbook on concrete brick and block making is just coming from the press. This book is right up to the minute with information on the following subjects and many others:

The field for concrete. Selecting materials. How to proportion. How to cure product. Plant arrangement. How to estimate. Comparative tests. Table of compression working values. Ways of making product. Various building systems. Forming the product. Steam curing. A waterproof building system fully illustrated. Weights of materials. Hints on selling. Profits in concrete.

It has cost a great deal of money and time to gather this valuable information, but this book is being mailed absolutely free to all who ask for it, as it is designed to assist those now in the concrete business and those who contemplate putting their concrete plants on the best possible basis.

This book is being mailed free by the Helm Brick Machine Company, 311 Bank Building, Traverse City, Mich., who are the manufacturers of the well known line of Helm presses for making **Dry Wall** blocks and pressed cement brick. The **Dry Wall** block system saves the cost of furring and lathing for the builder and the blocks meet with a ready sale wherever introduced. Full information pertaining to this improved line of machines for hand and power operation will also be mailed free to any one interested.

HANDLING OF EXPLOSIVES.

The Du Pont Powder Co. of Wilmington, Del., has just issued a very instructive book describing the proper way of handling explosives.

As large amounts of powder of all kinds are used daily in quarrying cement rock and as unfortunately accidents still occur in great number, the information contained in this publication should be imparted to every one handling explosives or superintending quarries at which blasting has to be resorted to.

The book contains numerous illustrations showing in an interesting manner the method of applying the fuse and of placing the charge. All necessary tools are fully described and many rules of precaution are given, which are bound to obviate disaster, if properly obeyed.

Our advice: Send for the book at once and study it carefully.

CHICAGO CEMENT SHOW.

Do not fail to attend the coming Cement Show at the Coliseum on February 17-23. You may believe you know all about concrete construction, reinforcing metal, concrete blocks, brick and tiles, or about waterproofing, decorating and the ornamental uses of cement. But, upon coming to Chicago and attending the show, you will see that it is well worth obtaining a general and concise view of the whole field of application.

Moreover, you will be surprised to see how instructive and artistic the exhibits are. Whole volumes of reading matter can not give you as much information and keep you posted as thoroughly on the last year's progress in the industry as a visit of a few hours at the Cement Show and as an occasional discussion of the subjects you are most interested in with the various exhibitors.

Come and let us get acquainted or let us renew our friendship of a year ago.

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
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Western Office:
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Jeffrey Elevators AND CONVEYERS

for handling your raw and finished products from the crushers and bins with the least trouble and expense.

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Works: Martins Creek, Pa.
Manheim, W. Va.
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Quality unexcelled The Recognized Standard American Brand Always Uniform

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2. Does as much work in two hours as a man can do in ten hours the old way, and does it BETTER.
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Send me price and all literature on your new
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Peerless Portland Cement

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Every Barrel Guaranteed

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
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to be unequalled for fineness, wonderful development
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More Litigation Over Tile Machine Patents

THE TROUBLE.

The success of the Schenk Machine seems to arouse the envy of other manufacturers and we find them, from time to time, trying to build and put on the market a machine which will compete with the Schenk. At first, of course, they are very, very careful and their ideas and principles are vastly different from any used in the make-up of the Schenk, but as practical tests are made we find them drifting away from their own inventions and utilizing Schenk features, one by one, until the completed machine takes on the appearance of a half-brother. It is at this stage of the game that we, like any other man when his toes are trodden on, resent the act and appeal to the Law for protection, and thus far we have received it in three separate decisions from the United States Circuit Court.

THE DECISIONS.

Number One:

March 27, 1909, by the Honorable Henry T. Reed, presiding over the United States Circuit Court, Eastern Division, Northern District of Iowa.

Number Two:

April 16, 1909, by Judge Walter H. Sanborn, presiding over the United States Circuit Court, Fourth Division, District of Minnesota.

Number Three:

October 22, 1910, by Judge Henry T. Reed, presiding over the United States Circuit Court, Central Division, Northern District of Iowa.

In each of these three cases our claims and patents were validated and the Court issued a perpetual injunction, restraining the infringing manufacturer from directly or indirectly making or causing to be made, using or causing to be used, or vending to others to be used, any tile machine containing, embodying or employing principles or ideas as set forth in our patent claims.

THE MEANING.

This means that the Schenk Machine is the only Cement Drain Tile Machine built which is protected by the basic patents, and that any person, buying, using or selling any other make of tile machine is laying himself liable to suit for infringement. It means that the Cement Tile Machinery Company, as owners of the Schenk Patents, has the exclusive right to manufacture, sell and use tile machines which embody the "Revolving Packer Idea" of producing cement drain tile, and it means that this right will be protected, as it has been in the past, by the United States Courts.

THE MORAL.

All this brings out a moral which should be learned by all those intending to purchase cement drain tile machinery. To wit: When you can buy a machine which is guaranteed to do more work, better work at less expense than any other machine on the market; a machine which has gone through the experimental stages, a machine which is protected by the basic patents which have been validated by the Laws of our country, and a machine which can never be troubled by patent litigation, don't buy the other kind.

Our Literature describing the Cement Drain Tile Industry in general and the Schenk Cement Drain Tile Machine in particular is absolutely free for the asking. Do it Today.

Literature is Free.

The Cement Tile Machinery Co.

"Creators of the Cement Tile Industry"

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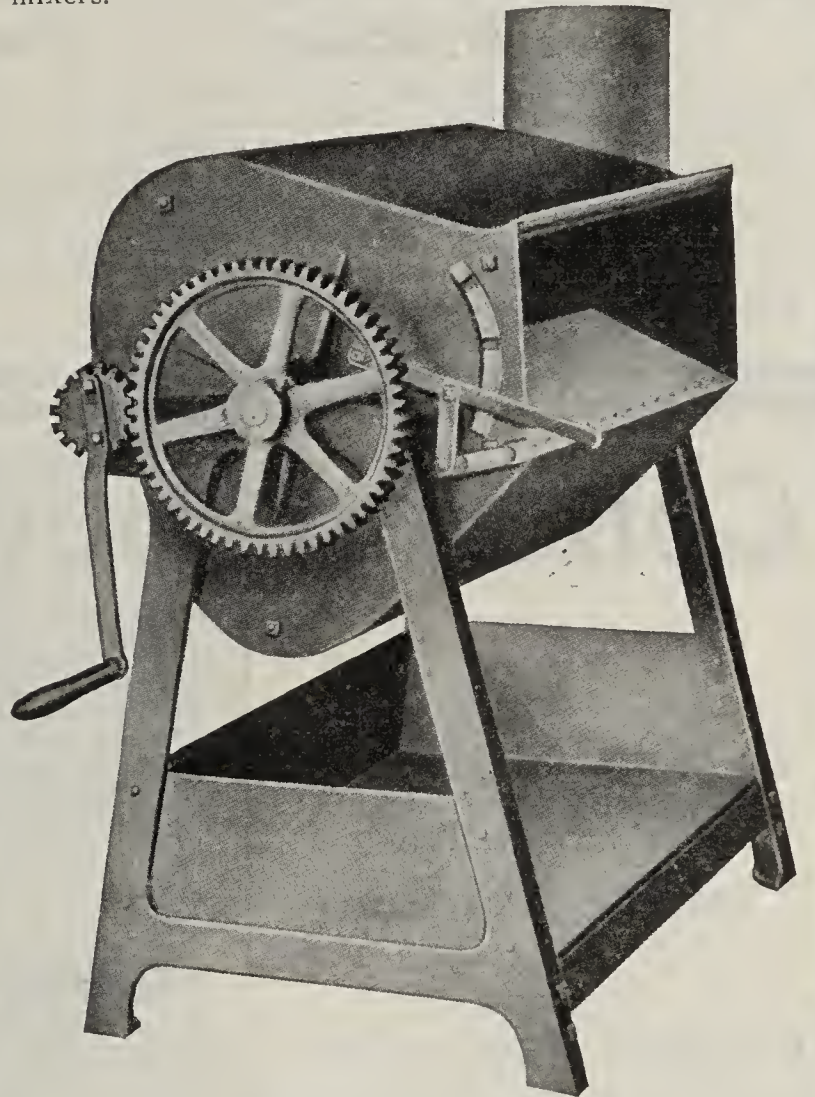
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A prominent engineer says "Less cement well mixed is better than the usual quantity *poorly mixed*. A good mixing machine is an absolute necessity, even on small jobs."

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For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

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By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

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These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

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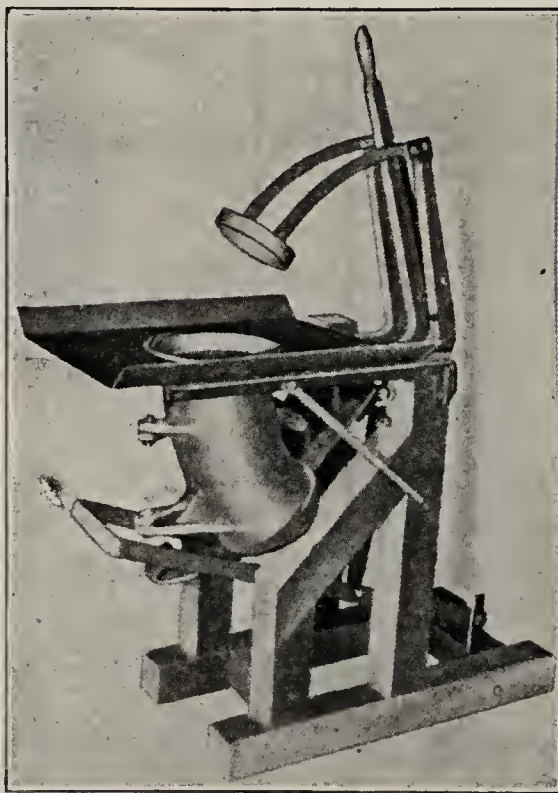
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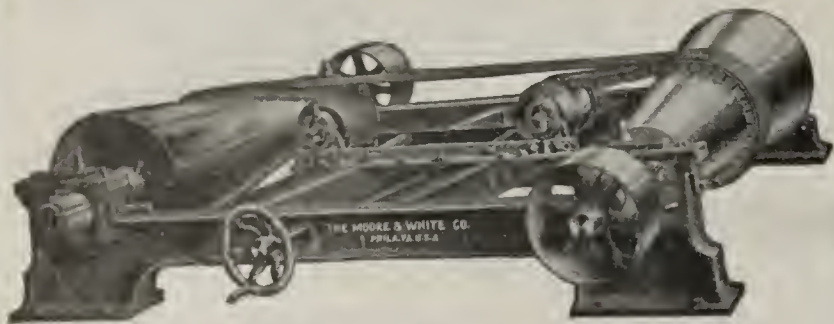
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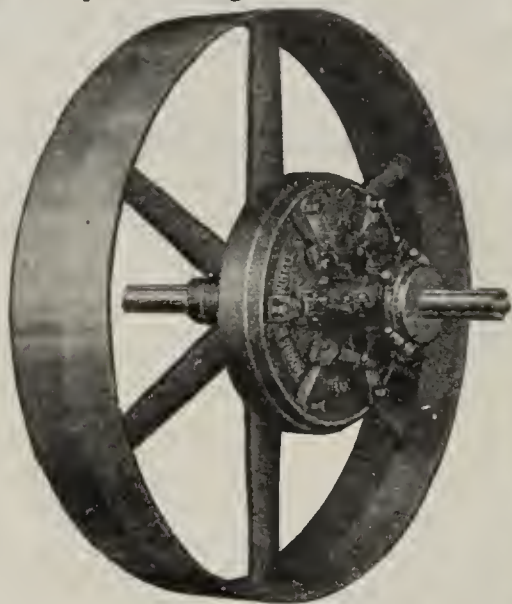
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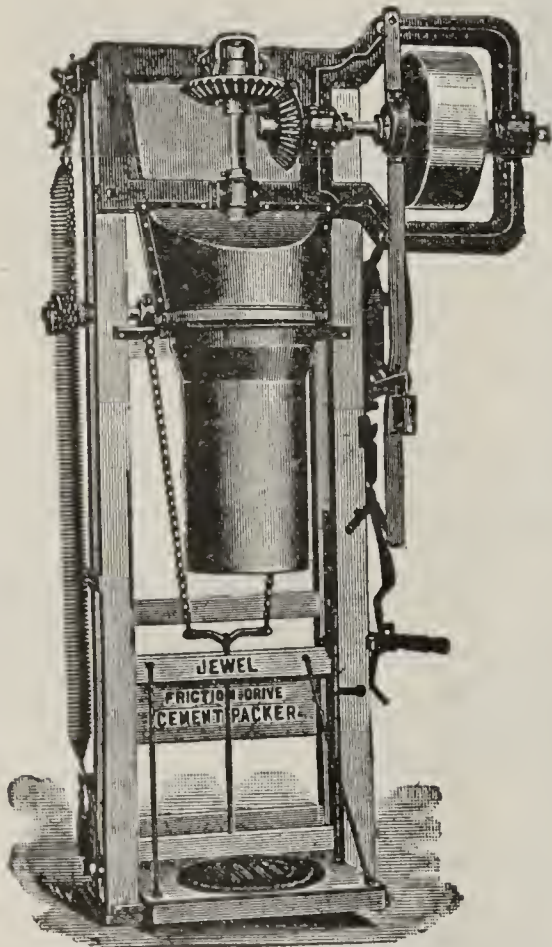
Perfect uniformity in all those properties which make Portland Cement of the highest quality distinguishes Universal Portland Cement. Absolute uniformity in soundness, strength, fineness, color and setting qualities is secured by the use of materials, methods and devices representing the highest perfection in the manufacture of Portland Cement.

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Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

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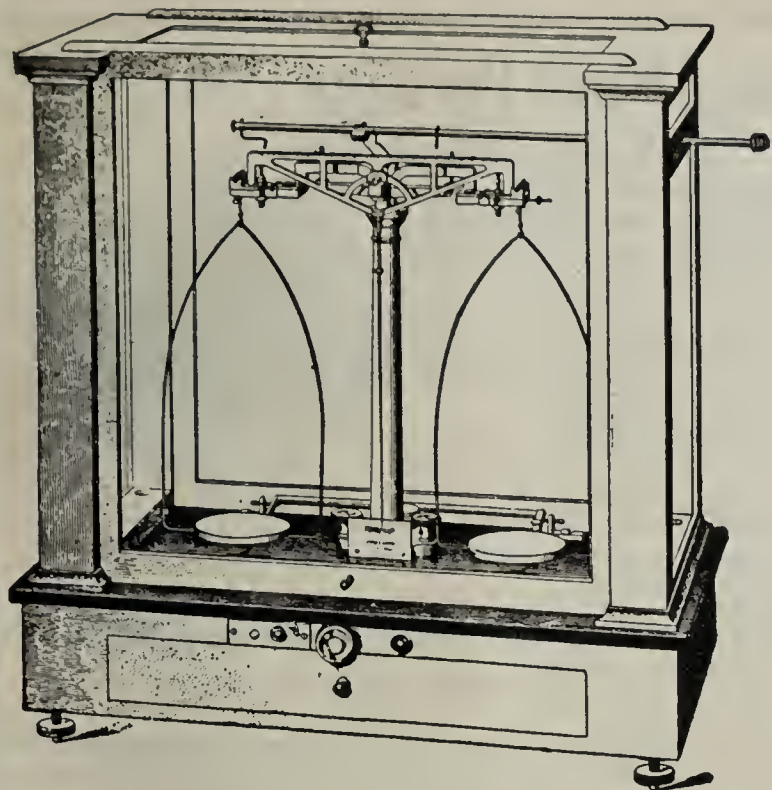
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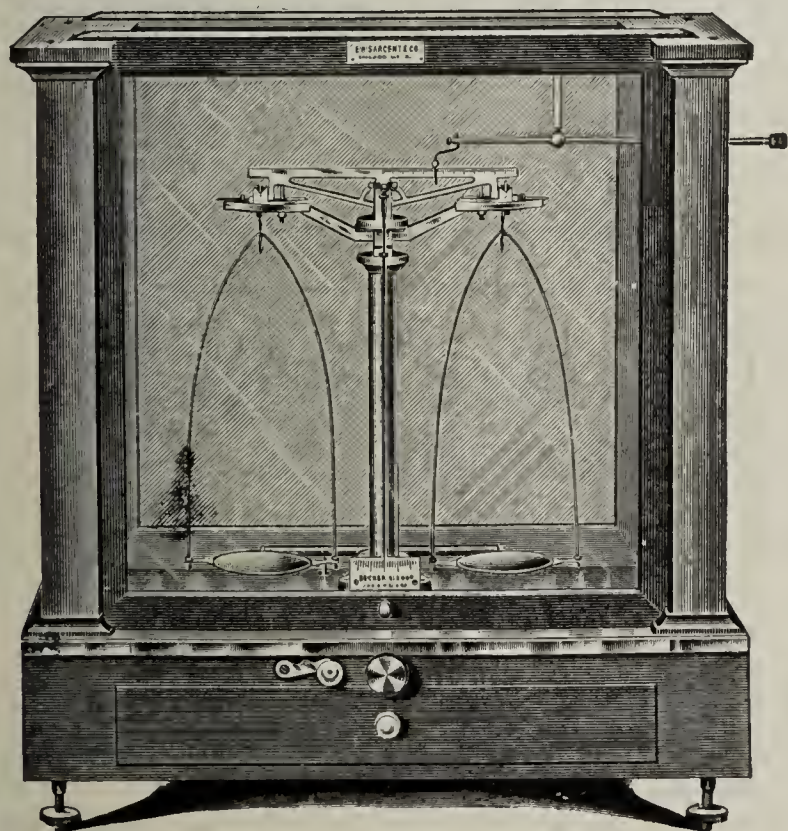
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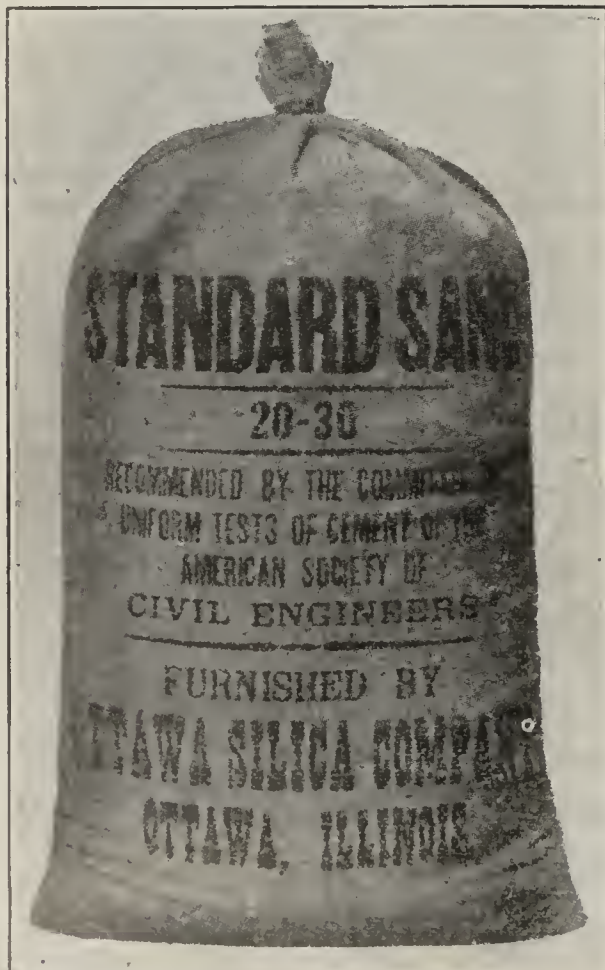
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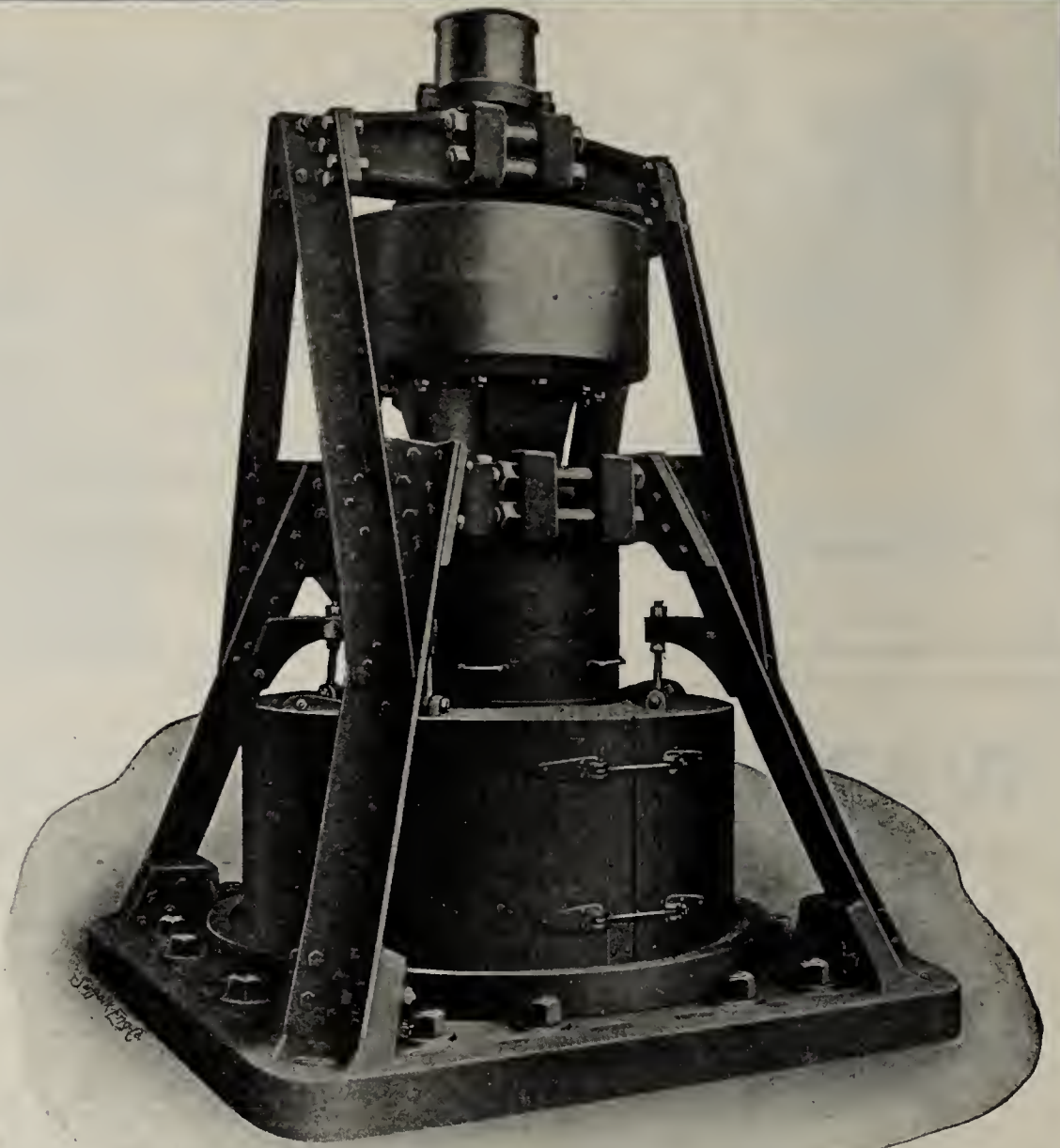
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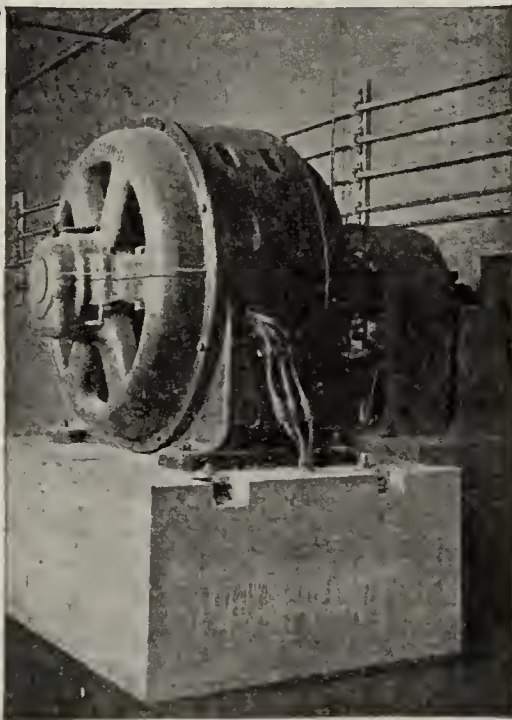
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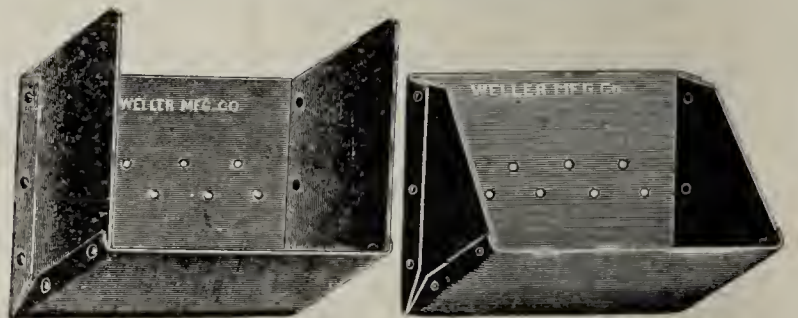
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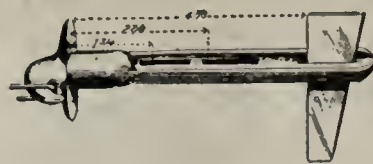
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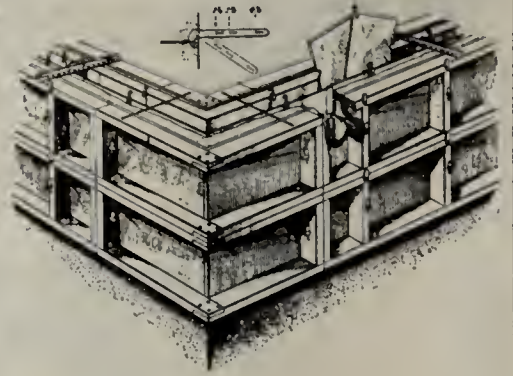
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This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

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THE PERFECT BRICK MACHINE

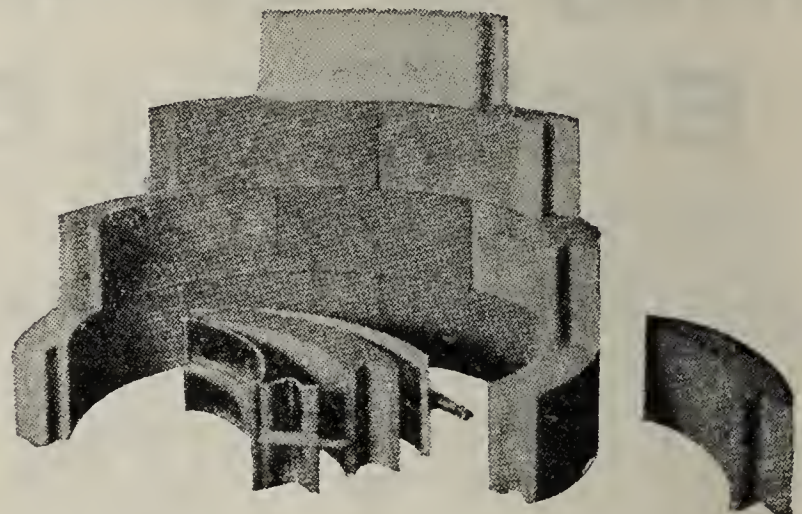
THE PERFECT CISTERN AND SILO MOLDS

ARE USED IN ALL PARTS OF THE WORLD

OUR MOLDS are the BEST and CHEAPEST ever offered to the public



THE PERFECT is the Simplest, Easiest, Fastest, Most Durable, and is operated with less labor than any other brick machine, therefore yielding more profits to the manufacturer. If you are looking for the latest improved and up-to-date invention you will make no mistake in purchasing the PERFECT.



The Perfect Well, Cistern and Silo Mold.

HERE IS OUR PRICE LIST

No 3 Circle Mold is 3 ft. diam.	No. 10 Circle Mold is 10 ft. diam.
" 5 " " " 5 ft. "	" 12 " " " 12 ft. "
" 7 " " " 7 ft. "	" 14 " " " 14 ft. "
	" 16 " " " 16 ft. "

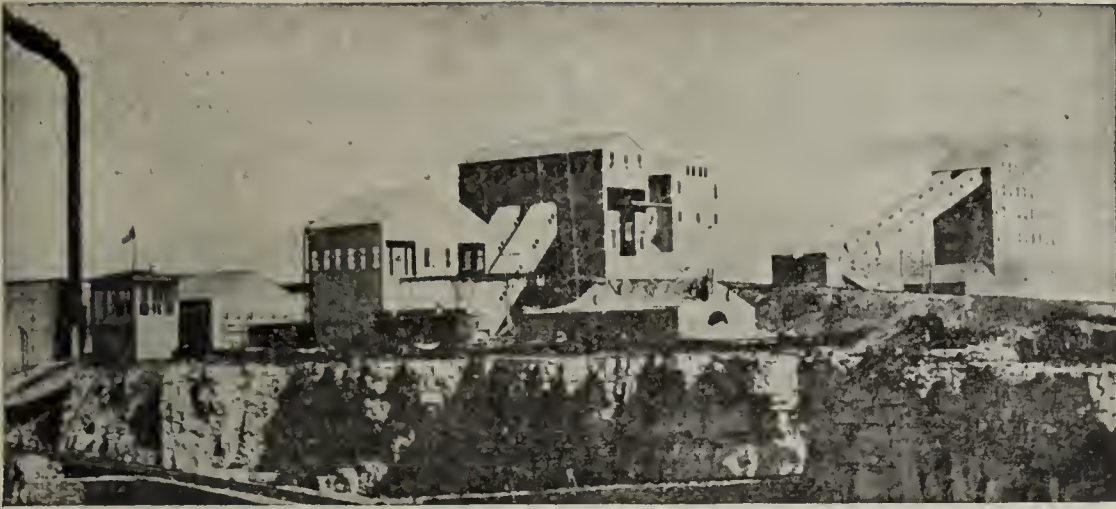
All sizes up to 7 foot retail at \$12.00 each.

All other sizes retail at \$15.00 each.

The Circle Molds vary in length from 22 to 28 inches, depending upon the diameter of its circumference.

In ordering Circle Molds always give the diameter of what you are going to build and I will then understand the kind of a circle mold you desire.

C. S. WERT, 602 North Main Street, Kendallville, Indiana, U.S.A.



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

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Engineers and Contractors

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COAL, SAND, GRAVEL, ORES, ASHES, ETC.

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Elevating and Conveying Machinery.

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The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

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Fitted for steam or air.

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4,000 ft. 12 inches
30,000 ft. 8 in. Cast Iron
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40,000 ft. 3 1/4 inches
60,000 ft. 3 3/4 inches
8,000 ft. 5 1/2 inches
9,000 ft. 6 1/4 inches
1,000 ft. 6 3/8 inches
1,250 ft. 8 1/4 inches

ready to assemble, at a saving to you of 30 to 60 per cent. Send plan of the work you have in view and let us make you an estimate.

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12—1,000 gallon capacity tanks.
42—1,500 gallon capacity tanks.
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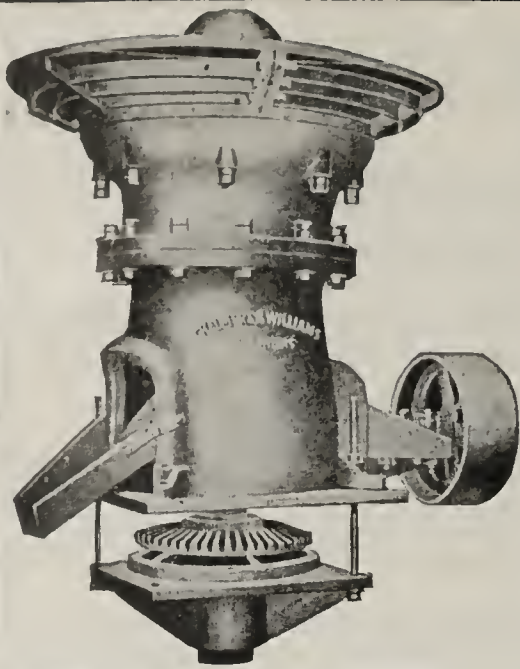
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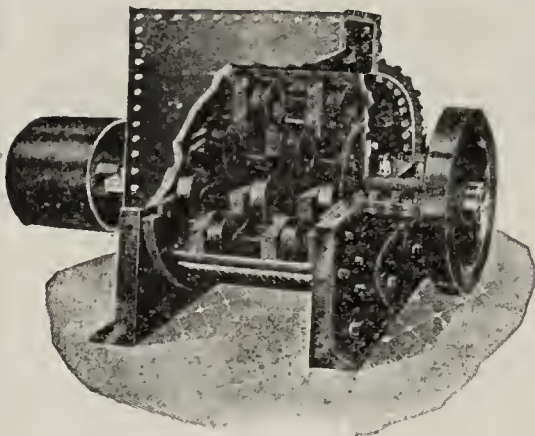
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A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



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¶ We now introduce a system of handling concrete by gravity which, by reason of its startling reductions in the cost of mixing, conveying and distributing concrete, is destined to revolutionize the handling of concrete.

This system, while new to the Central and Middle West, and Eastern States, is in accepted usage by engineers, architects, contractors and builders, and a **demonstrated success** in other sections of the country.

The G-Y System

The First and Only Practicable and Perfected Gravity System Extant

The idea of handling concrete by gravity is not new, as many crude attempts at it have been made by both manufacturers and individual contractors. The thing of vital significance in the G-Y System is that out of these crude attempts has evolved the first and only **practicable, highly developed and perfected** system.

Briefly, the system is this: (1)—Mixing in any suitable batch mixer. (2)—Hoisting by means of a skip to an elevated hopper. (3)—Conveying, distributing and placing by means of a **suspended pipe operated by cables, booms and swivels**.

Basic Patent Rights

¶ Without these practical, simplified appliances, namely—**suspended pipe, swinging boom and universal swivel**—the general utility of the gravity principle is of little value; and, these appliances, which are the **essentials** of the G-Y System, are fully covered and protected by broad, basic Letters Patent, which will be rigidly enforced in each individual case of infringement.

Sweeping Reductions in Cost and Time of Concrete Construction

The G-Y System enables the phenomenal record of 40 cubic yards per hour placed. Ten men operating the G-Y System can easily place 300 yards of concrete per day as compared with 160 yards which is considered a high record for **thirty-five** men with wheelbarrows or carts—in other words, less than one-third as many men place nearly twice as much concrete with the G-Y System.

For specific and detailed data as to costs of placing, economies, etc., write us. We can give you information of vital interest.

Adapted to All Classes of Construction

The G-Y System is adequate to all classes of construction and every variety of architectural design—from simple foundation work to the most complicated column, dome and frieze work.

Complete Fund of Engineering Data Available

All problems as to maximum and minimum angles at which plastic concrete can be run, the practical limits and strengths of booms, the lengths of free ends of swivel pipes, etc., have been demonstrated in **seven years of actual construction experience**, and any job, no matter how large or involved, can be laid out in detail in the engineer's office and all details as to cost of installation, operating cost, quality of concrete delivered, etc., settled in advance with accuracy and certainty.

Economical Installation

The economies resulting from the installation of the G-Y System are so overwhelming, that the cost of installation is not a consideration in any case.

Aside from the appliances which are necessary anyhow in any proper installation for wheelbarrow and cart methods, the G-Y System calls for only four extra appliances, the cost of which is offset by the saving of the cost of wheelbarrows and carts and staging for runways.

Method of Introduction Contractors and builders will be licensed to use the G-Y System, including its patent appliances, on royalties based on the cubic yards per job; and blue prints of the layout for each job will be furnished together with bill of materials, specifications, etc.

Write for Details This is the most vitally important announcement to concrete engineers, architects, contractors and builders which has been made in years. It calls for immediate and serious investigation.

Users of the G-Y System will be able to **underbid** successfully on any concrete construction job; and as our capacity for supplying equipment for the use of the system is for the time being very limited, it is urgently important that those interested make their arrangements with us without delay.

William B. Hough Company

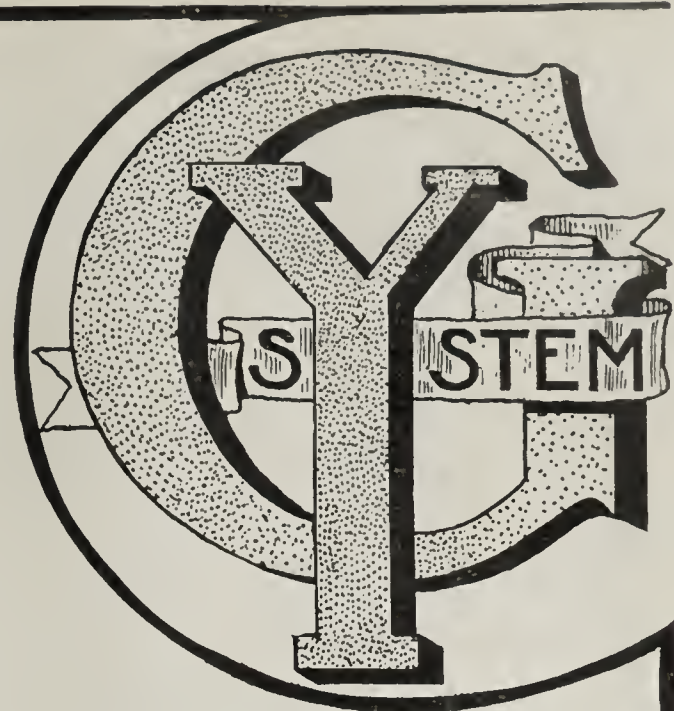
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The Gearless Cement Brick and Block Machine

The Gearless

Cement Block Machine has all the points of superiority of the Gearless Cement Brick Maker.

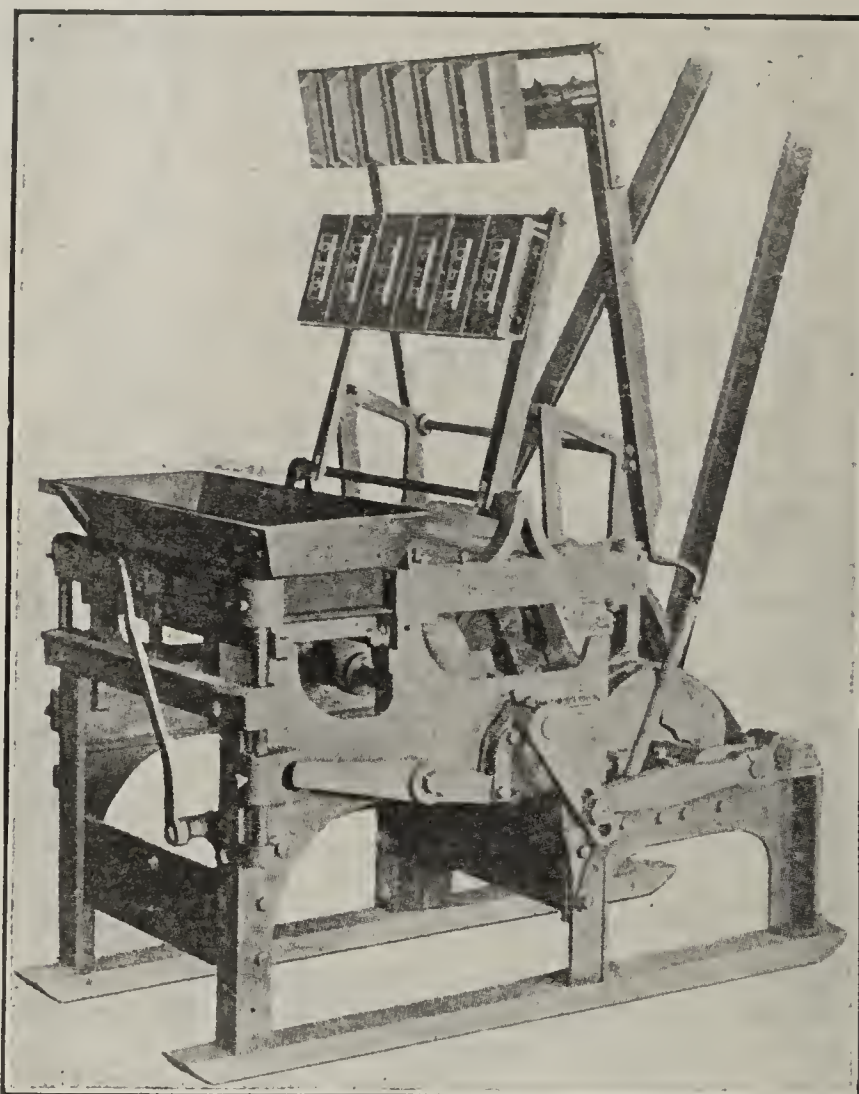
On the Gearless Cement Block Machine three times as many blocks can be made with the same labor as can be made with any other block making machine, and a superior block can be made.

It has the advantage in that it will make blocks 4" x 4" x 8", 8" x 4" x 8", 12" x 4" x 8", 16" x 4" x 8", 20" x 4" x 8", 24" x 4" x 8".

A wall laid up out of blocks made on the Gearless Block Making Machine has a complete air space throughout, so that no dampness can draw through and saves lathing and furring out, and will make the warmest as well as the coolest building that can be made, as well as being fireproof.

The blocks can be made with any face desired by changing the face plates, which is done very quickly and very easily.

The Gearless Block Machine is by far the best machine on the market to-day.



3. Produces 1,000 more brick a day with the same labor and less cement than other machines.

4. Operating cost is much lower than that of other machines.

5. Has no cogs to clog and wear out.

6. Operates by long leverage--the most positive of powers.

7. Mechanically tamps six brick at one operation.

8. Bricks made on other machines are pressed or hand tamped, lacking the finish and durability of the Gearless brick.

9. Two blows of the main tamper --- a thousand pounds of shock to the square

inch--insures full uniting value of cement and sand, and makes a Gearless brick indestructible.

10. A Gearless brick is troweled on edges and ends, instead of on top and bottom.

11. Each Gearless brick has a perfect mortar space.

12. Wearing surfaces of the Gearless machine are large enough to reduce friction on parts to a minimum.

13. Mortar distribution is perfect and practically instantaneous.

14. Hopper slides on a track and operation of removing hopper returns all surplus to mixing box.

15. There is nothing to get out of order on a Gearless machine. It is simplicity itself.

16. A Gearless brick maker operating with power can be changed in a few minutes to operate as hand machine.

SIXTEEN BIG POINTS

That Prove the Superiority of the Gearless Cement Brick Maker

1. It is the most durable machine on the market.

2. Produces the most lasting cement brick make.

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Patent Applied for

GLOVERSVILLE, NEW YORK

Inventors & Manufacturers

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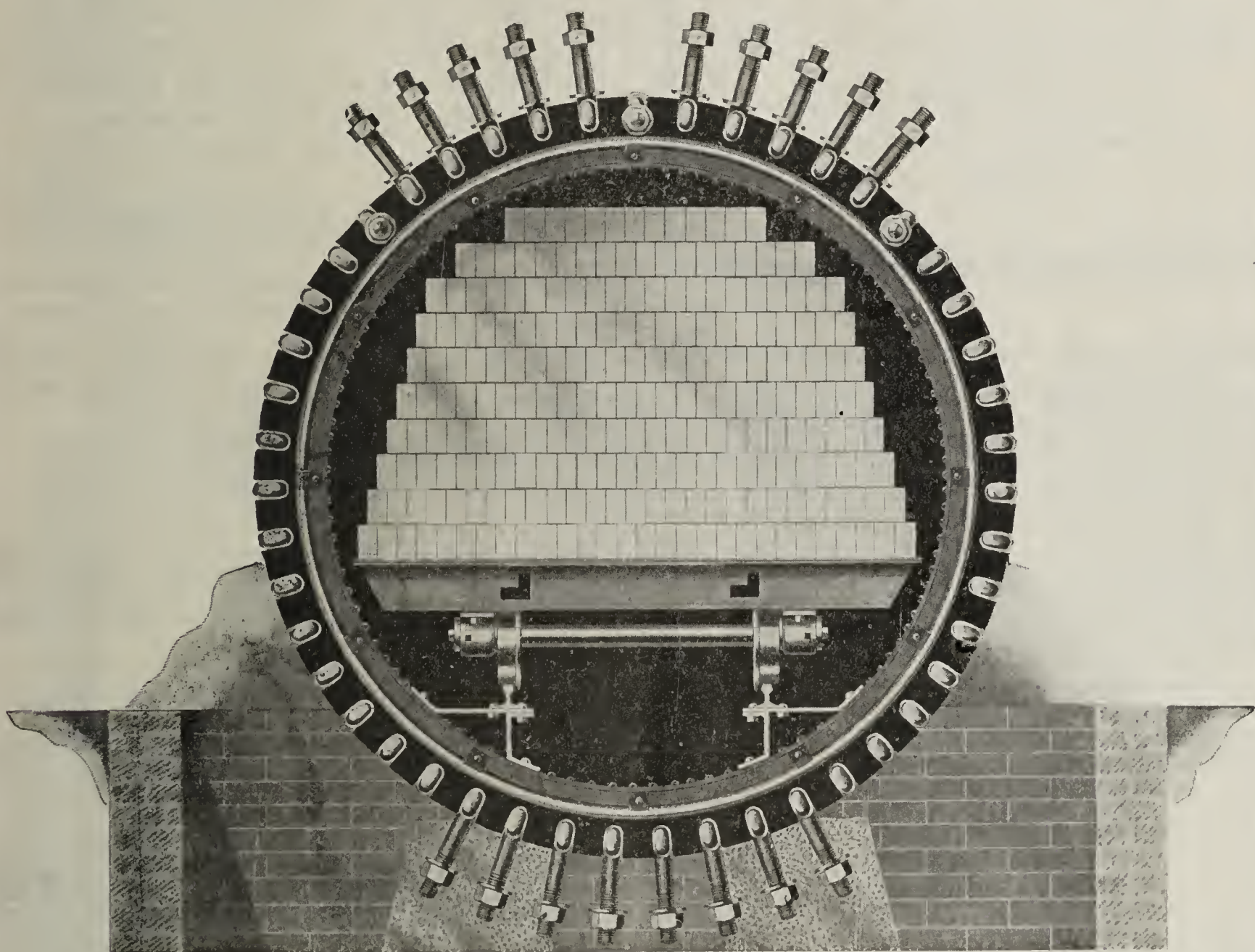
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is the safe, sanitary, economical treatment for concrete
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**Biggest, Broadest, Best Line of Con-
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Red Cross Explosives for Quarries

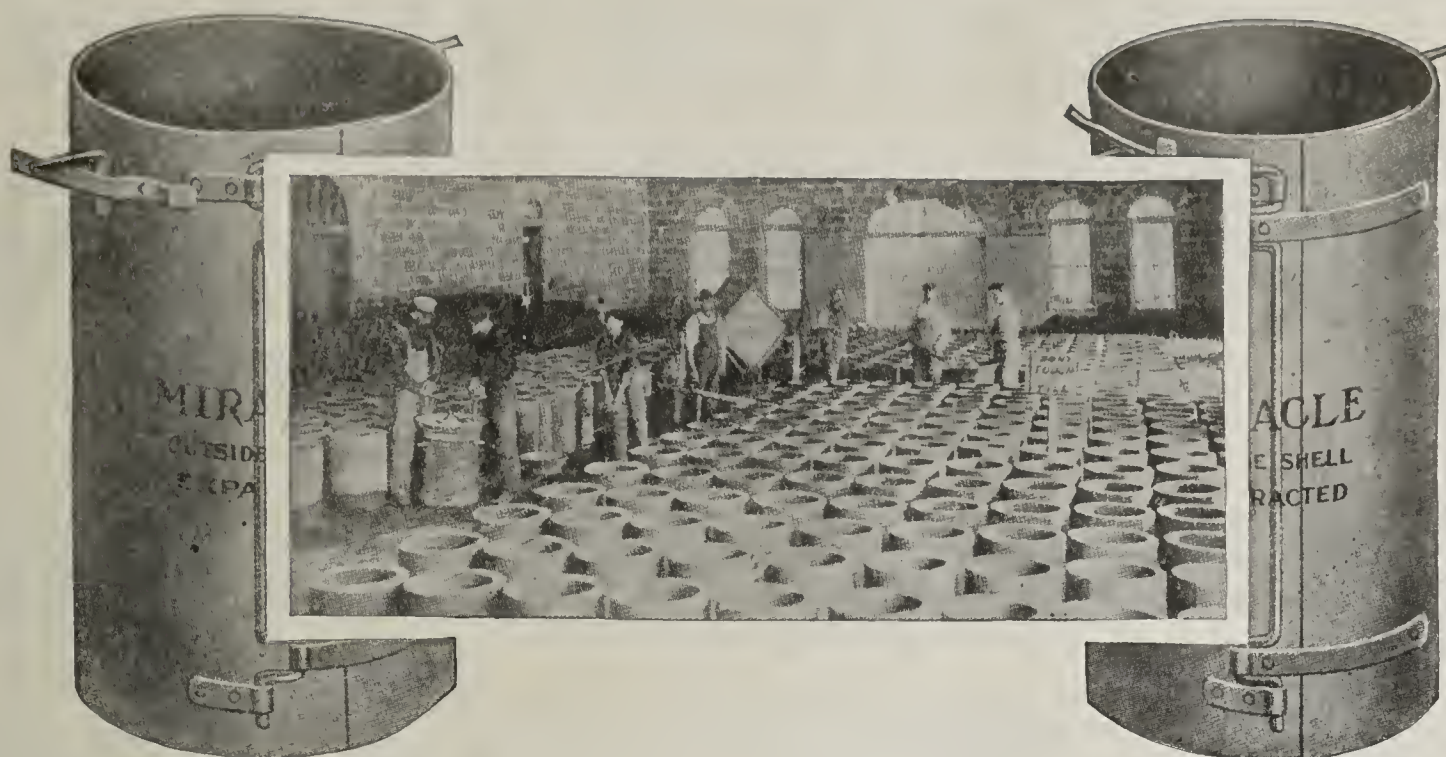
Low Freezing, Slow Freezing, Quick Thawing

Can not be properly exploded with anything
weaker than No. 6 (red label) Detonators



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A Growing Demand

for cement sewer pipe and drain tile has created a great opening for a lucrative business in this field. Better sewer pipe, drain tile and irrigation pipe is needed, and lower prices are demanded. An investment in

Miracle Pipe and Tile Molds

will double itself in thirty days. \$80.00 worth of 24" molds netted Mr. J. M. Minnis, Bartow, Fla., \$2,000 in sixty days. All large sizes equally profitable. Write for descriptive catalog "L" telling all about cement pipe.

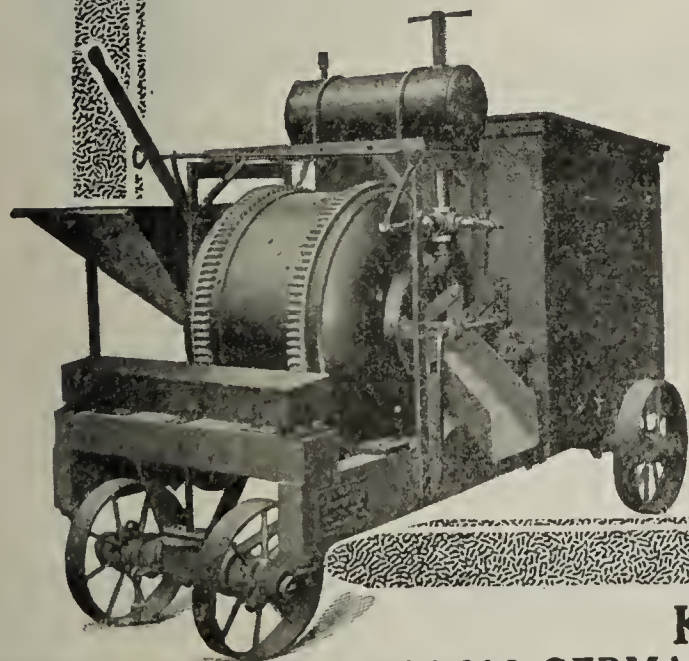
MARSH CO.



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CHICAGO, ILLINOIS**

By Any Standard of Quality The Koehring Concrete Mixer Is Peer

In Quality of Product
—Quantity of Output—
Manual Labor Saved
and Dependableness
of The Machine—
None Other Excels.



THREE independent mixings in the one drum, each performed by a positive mechanical force, with no sharp angles or corners is a guaranty of quality of mixing.

Lifting and pouring from the side, casting alternately from end-to-end, breaking over against heavy cast iron heads of the drum and a constant pouring off the inner end of the discharge chute represents a rapidity of mixing no other equals.

Discharging by merely raising the inner end of the discharge chute and always taking out the exact quantity desired, is manual labor economy you know is the minimum.

The heaviest constructed drum on any mixer, resting on trunnion rollers placed close to the ends, the rollers cast with wide faces, chilled as hard as tempered steel, and a double gear drive with pinions placed high to prevent binding in case the drum settles, comprises a dependableness the greatest mechanical genius will never question.

Built in types and sizes for every requirement; equipped with gasoline, steam or electric power.

It's chock full of dollar-saving quality—quality in the concrete and quality in the machine. Ask for "Catalog B."



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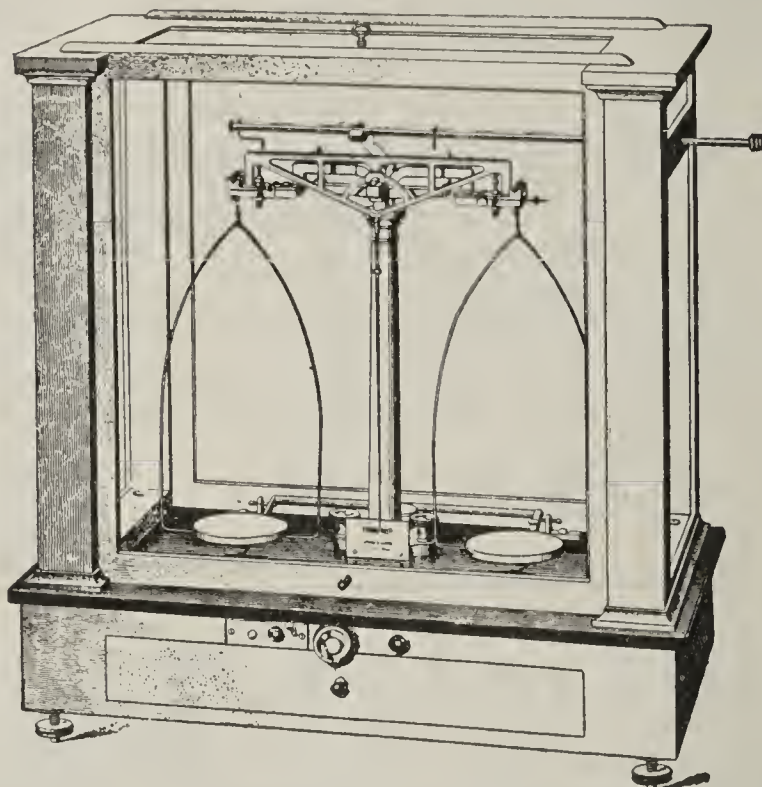
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Specially adapted for determining Sp. Gr. of Cement.

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Capacity, 200 grm.; Sensibility, 1-20th mgr.

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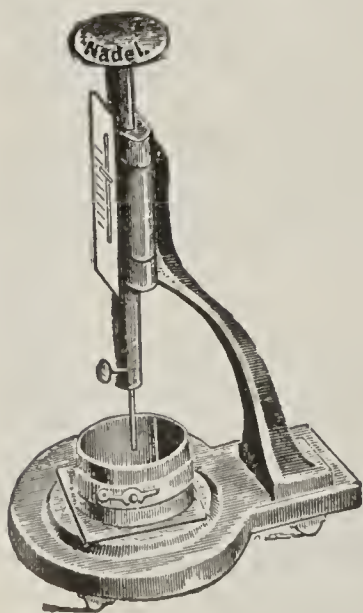
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For Protecting Edges of Concrete Curbs, Steps, Columns, etc.



THE ONLY EFFECTIVE
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OFFERED TO THE CON-
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This bar has been in public use for more than ten years as the
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WAINWRIGHT STEEL-BOUND CONCRETE CURB

Absolutely Non-breakable. Cheaper than Granite.

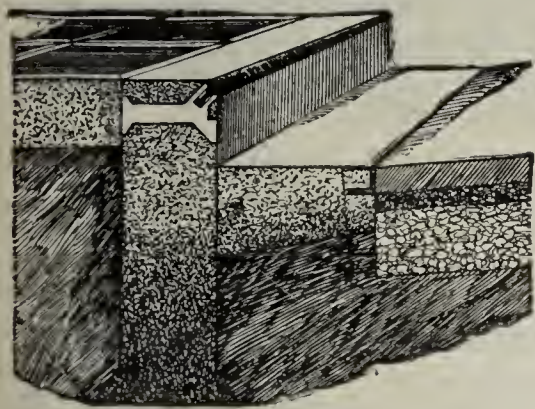
Handsome than Granite and Much Stronger.
Continuous in Construction, hence Never Out
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GALVANIZED STEEL CORNER BAR pre-
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Cannot be Displaced by Frost.

Never Requires Re-setting or Repairs.

MECHANICALLY PERFECT AND UN-
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THE BEST IN THE WORLD

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**THIS CURB WILL STAND HARDER USE AND LAST TEN TIMES
AS LONG AS PLAIN CONCRETE CURBING**

CONTRACTORS can make money by laying this curb.

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ARCHITECTS are invited to read pages 1278 and 1279 "Sweet's index"

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from the power plant to the finishing mill, may be purchased of Allis-Chalmers Company with the assurance of the efficient operation of the whole mill, and the advantages of undivided responsibility

Plants equipped with Allis-Chalmers Cement Making and Power Machinery produce the highest quality of finished product at minimum operating and maintenance costs.

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Plain Rounds, Plain Squares, Square Twisted

All sizes from 5-16 to 1 1/4 inches. Flat bars from 1/4 x 1 inch to 3/8 x 2 1/2 inches

WE GUARANTEE IMMEDIATE DELIVERY

No extra charge for cutting to length

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CEMENT

... AND ...

ENGINEERING NEWS



Concrete Culvert on Bessemer & Lake Erie R. R.

The B. & L. E. R. R. has recently completed at Rural Ridge, Pa., a double concrete culvert of two 26 ft. spans, 156 feet long. The work was under the general charge of the chief engineer, H. T. Porter, and the engineer of bridges, H. H. Harmon, of Greenville, Pa. The T. A. Gillespie Co. of Pittsburg were the contractors. It is a preliminary step in the elimination of many of the road's trestles. The illustration shows also the steel towers and the plate girder spans, the culvert being built around one tower. The total yardage in this culvert is over 3200.

It is a recent development in railroad work to replace even first-class steel trestles with earth fills. It is possible to use stone culverts, but today concrete is used almost exclusively. This is a particularly good example of moderate sized culvert work.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address—"Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription. \$2.00 Per Year
Foreign Subscription. \$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON - - - - - Advertising Manager

Chicago, February 1911.

I. C. JOHNSON, 100 YEARS OLD.

On January 28th, an English cement manufacturer, Mr. Isaac Charles Johnson, completed his 100th year at his home at Gravesend and, on this occasion, received the hearty congratulations of King George and of all Portland cement manufacturers of both Europe and America.

The fact that a cement manufacturer lived to be a hundred years in spite of all the cement dust he inhaled and all the trials and tribulations of the industry would have been enough to induce his fellow workers to celebrate the day. But, not only his good fortune of enjoying the best of health in his old age made the whole cement world take notice of the rare event; their main object was to do homage to the first practical Portland cement manufacturer, to a man who, though not the inventor of Portland cement, undoubtedly deserves credit for having perfected the manufacture of Portland cement so that it became a commercial success and in time a world-wide industry.

The name of Portland cement was the invention of Aspdin and was given by him to a mixture of lime stone and clay which he burnt, in distinction from his predecessors, at a higher temperature than required for the calcination of hydraulic limes and Roman or natural cements. Aspdin's process, as a rule, resulted in a product nowadays termed underburnt Portland cement. The hardened cement, therefore, represented a yellowish stone of the appearance of Portland stone, the best natural building stone quarried in England. However, now and then, Aspdin obtained also real Portland cement in the modern acceptation of the term, namely whenever his limestone and clay mixtures happened to contain both ingredients in the proper proportions. As he did not possess any chemical knowledge, it was impossible for him to ascertain what ratio of lime to clay substance was required and, for this reason, he manufactured, at the best, a Portland cement of doubtful reputation, a cement that hardened well in one instance and caused the collapse of a structure in another.

About the year 1840, I. C. Johnson took up the subject of manufacturing Portland cement and was assisted in his efforts by a sufficient knowledge in chemistry to find out that all vitrified mixtures of limestone and clay (which he obtained only accidentally at first in manufacturing a natural cement), were considerably higher in lime than Roman or natural cements. These vitrified parts were formerly rejected, as the cement manufacturer aimed to obtain a product which slaked and hardened quickly, hence either hydraulic lime or natural cement. Only an occasional examination of the rejected vitrified half-fused particles convinced Johnson that this was an entirely different cement

which hardened relatively slowly and obtained far superior strength to the cements produced up to that time. His chemical knowledge enabled him henceforth to produce this vitrified cement, that is to say real Portland cement, of sufficient uniformity to obtain a marketable product of good reputation.

Thus, Johnson overcame the first difficulties in manufacturing Portland cement. This cement soon became so popular that a large industry sprang up, at first, in 1848, in England, and since 1850 also on the European continent.

His 100th birthday, therefore, is a welcome opportunity for all Portland cement manufacturers to show Mr. Johnson their appreciation of the services rendered by him to the industry during its infancy.

THE HARDENING AND CONSTITUTION OF PORTLAND CEMENT.

By S. Keiserman.

(With criticism by Dr. W. Michaelis, Sr.)

(Continued from Page 12.)

Calcium Silicates:

In order to study the hydration of the calcium silicates, a series of fused products of the following composition was prepared and examined in the usual manner:

- 1 $\text{Ca O} \cdot \text{Si O}_2$
- 1,5 $\text{Ca O} \cdot \text{Si O}_2$
- 2 $\text{Ca O} \cdot \text{Si O}_2$
- 2,5 $\text{Ca O} \cdot \text{Si O}_2$
- 3 $\text{Ca O} \cdot \text{Si O}_2$

In fusing these mixtures of calcium oxide and silica it became evident that the melting point of the di-calcium silicate was the highest and that of the mono-calcium silicate the lowest. The first two fused products, containing one molecule and one and one-half molecule of calcium oxide to one molecule of silica, formed, upon cooling, hard yellow porcelain-like substances that showed strong double-refraction under the microscope after having been reduced to powder. The remaining three products, however, with two, two and one-half and three molecules of calcium oxide to one of silica, crumbled partly into dust when cooled quickly. The remaining solid portion was the greater the more calcium oxide the fused mixture contained. The same has been observed by Schott and others.

The mono-calcium silicate, mixed with water and observed under the microscope, did not show any change during the first two weeks. Only then a slight decomposition of the grains set in very slowly, and crystalline bodies of oval shape could be observed, with one of their ends sharp-pointed. As similar crystalline products were never discovered in commercial cements, their further examination was abandoned.

The preparation originating from the fused lime-silica mixture with one and one-half molecules of lime showed the same crystalline bodies; but, in addition to them, large hexagonal crystals closely resembling those observed in cement. As anthrapurpurine stained them also as strongly as the latter, they could rightly be assumed to be identical. Similar hexagonal crystals were described by Le Chatelier in microscopic sections of hardened cement and, upon analysis, found to be composed of pure calcium hydrate. Their composition could be verified by the following experiment:

Well-burnt and finely powdered lime was gauged with water and the process of hydration observed under the microscope, whereby the air had no access to the preparation. Also in this case the same large hexagonal crystals were formed, but, outside of them, no other bodies whatever. This proved that the large hexagonal crystals to be seen in cement consisted of calcium hydrate.

The disintegrated portion of the fused mixtures, with two, two and one-half and three molecules of calcium oxide, developed in contact with water, the same hexagonal crystals; these were the more numerous the more calcium oxide the fused mixtures contained. Besides these crystals, only a slowly precipitating colloidal mass could be seen.

However, the solid portions of the latter three lime-silica mixtures yielded preparations that were very interesting to observe. After 6 or 8 days the well-known hexagonal crystals became noticeable in small amounts; their number increased with the growing contents of lime in the fused mixtures. In the course of the next week a colloidal mass formed, which was acted upon by the staining solutions in the same manner as the colloids in cement. Anthrapurpurine colored it intensely; but neutral methylene-blue or saffranine did not stain it, while acetic acid solutions of the same dyes precipitated free silica that was colored immediately. Hence, the colloidal mass must be composed of calcium silicate which is mixed, most likely, with uncombined calcium hydrate in a fine state of subdivision.

Simultaneously with the colloidal mass, long fine needle-crystals were seen to form which radiated mostly from a central point. They were so thin that they were hardly visible and that they became recognizable only by the aid of the dark field illuminator. Moreover, they formed only in the presence of a closely limited amount of water. Too much water did not enable the needle-crystals to form and too little water dried the preparation out before they had a chance to crystallize. These fine needle-crystals were absolutely identical with those formerly observed in Portland cement, to judge from their exterior and optic properties, and showed the same behavior towards staining solutions. Some time after the first appearance of these minute crystals, needle-crystals of larger dimensions could be discerned in a few rare cases which were likewise radiating from a common point. They were never seen in cements. As they possessed the same properties as the small needle-crystals, they were most likely of the same origin and owed their larger size to continuous, uninterrupted growth.

The needle-crystals of the last preparations could be neither calcium hydrate nor pure silica, as we knew calcium hydrate to form large hexagonal crystals and as uncombined silica was stained by neutral methylene-blue, which these needle-crystals did not do. Consequently they must contain calcium hydrate and silica combined. This conclusion was strengthened by the following experiments:

Finely powdered dry calcium hydrate and silica half-hydrate were intimately mixed in the proportions of 1:2 and moistened with a small amount of water for microscopic preparations. After about four weeks, the needle-crystals described in the foregoing paragraphs became visible, those of larger dimensions being more frequent than the small crystals. At the same time a colloidal mass formed, the observation of which was difficult. If calcium hydrate and silica hydrate were mixed in the ratio of 2:1, large hexagonal crystals of calcium hydrate formed in addition

to needle-crystals, as had to be expected. The mixture of the two component parts in the proportions of 1:2, if stirred with water on a large scale, is known to harden well after about six weeks.

The same formation of needle-crystals of calcium hydrate and silica in combination with water could be observed at puzzuolana cements even more readily than at the last preparation. The natural puzzuolanas, which contain uncombined silica, are mixed with calcium hydrate for the sake of obtaining a hardening cement. The uncombined silica in them is, according to Gino Gallo, the part acted upon by the lime. It could readily be detected by staining with neutral methylene-blue or saffranine. Both of these active constituents of puzzuolana-cements, calcium hydrate and silica, could be seen to combine after a week, that is to say about the hardening time of Portland cements, whereby the same needle-crystals and colloids formed with which we were acquainted from former preparations.

These experiments proved beyond doubt that the fine needle-crystals, which were likewise to be found in cements, as well as the accumulation of colloids, consisted of calcium silicate. They seem to take an important part in the hardening of cements.

The question about the quantitative composition of the needle-crystals and colloidal mass can be answered by the experience made by Jordis and Kanter who mixed silica and calcium hydrate in aqueous solutions in widely differing proportions, but invariably obtained mono-calcium silicate. Thus, the calcium silicates forming during the hydration of cement, needle-crystals as well as colloids, are most likely nothing but hydrated mono-calcium silicate of the composition $\text{Ca O} \cdot \text{Si O}_2 + \text{aq}$; from a chemical standpoint needle-crystals and colloids differ only by their contents of water.

Calcium Chromites and Calcium Ferrites: The microscopic examination of the fused lime-alumina and lime-silica mixtures enabled us to clear up the nature of the bodies forming during hydration. With a view to contribute further proofs for the correctness of the facts so far established, chromium cements and iron cements were likewise subjected to a microscopic investigation. For this purpose it was necessary to study at first the behavior of fused mixtures of calcium oxide and chromium oxide on the one side, and of calcium oxide and iron oxide on the other, which were compounded to answer the following formulae:



The fused chromium compounds represented black-green masses showing a striped structure if only slightly magnified. The mono-calcium chromite, mixed with water, did not react even after several months. The fused mixture containing two molecules of calcium oxide, and even more that with three calcium oxide, developed, in the course of 2 or 3 days, green hexagonal double-refracting plate-crystals, which closely resembled those observed at calcium aluminates; the only difference between them was the green color of the former and the fact that they were slightly wider.

The fused mixtures of calcium oxide and iron oxide were dark brown masses of crystalline structure. Mixed with water they did not react even after several months. Similar fused products sent to me by another experimenter proved to be equally indifferent.

This observation coincides with Le Chatelier's and Hilpert's who found calcium ferrites to be unable to

hydrate and to harden. In opposition hereto is Schott's observation to the effect that they obtained some strength, though little, in the course of a month.

Chromium Cements and Iron Cements: The chromium- and iron-cements had the composition of a normal Portland cement in which the alumina was replaced by an equivalent amount of chromium oxide or iron oxide.

The chromium cement, a greenish crystalline mass, was acted upon by water much more slowly than normal Portland cement. Only a day after the cement was mixed with water, were green hexagonal double-refracting plate-crystals seen to grow out of a few grains of the finely powdered cement. They were identical with those formed during the hydration of the high-limed calcium-chromites. In a later stage of the hydrating process, the characteristic fine needle-crystals, hexagonal crystals and colloidal mass were formed. These products were exactly the same as in Portland cement and showed the same behavior towards dyes. During the hydration of the chromium cement, the chromium oxide was discovered only in the hexagonal plate-crystals as revealed by their green color. On account of the resemblance between chromium oxide and aluminum oxide it may safely be concluded that hydrated alumina cement, that is to say ordinary Portland cement, contains likewise all of its alumina in the form of hexagonal plate-crystals. This deduction coincides perfectly with the composition of the hexagonal plate-crystals of hydrated Portland cement formerly arrived at. The fine needle-crystals, large crystals and the colloidal mass of the preparation of chromium cement were colorless even in thicker parts of the preparation; they were consequently free of chromium oxide, which was another point in common with ordinary Portland Cement, that showed the same products of hydration to be free of alumina.

The iron cement, which represented brownish black brittle masses, hydrated even more slowly than chromium cement. After about two days, the frequently described fine needle-crystals, large hexagonal crystals and colloidal mass became visible, which were all absolutely colorless. Here and there the preparation showed red particles, containing iron oxide, which remained unchanged even after several months, in the same way as the powdered calcium ferrites.

The same observation was made by Le Chatelier in the case of a microscopic section of hardened Portland cement. Thus, in opposition to alumina and chromium oxide, the iron oxide does not take a part in the hydrating process, but remains perfectly indifferent.

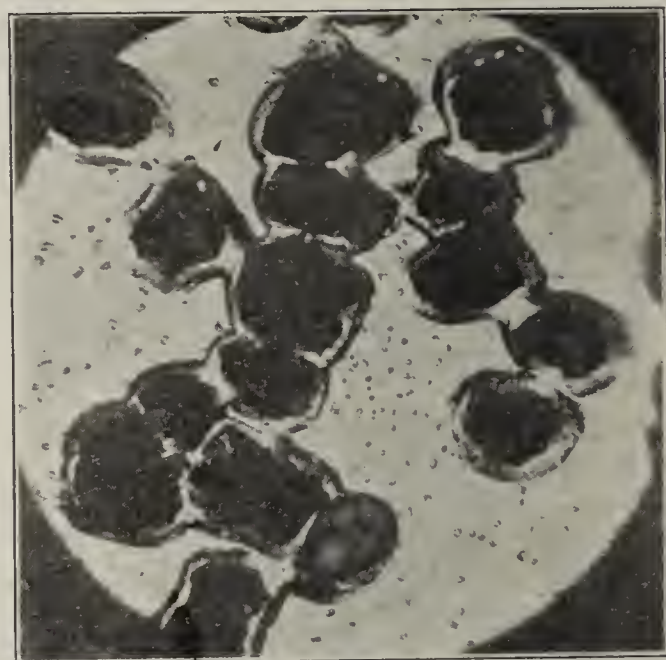
II. THE CONSTITUTION OF PORTLAND CEMENT CLINKER.

As mentioned in the beginning, previous researches proved crystallized chemical compounds to exist in Portland cement clinker, but their chemical nature remained unexplained up to this time. The results obtained during the study of the process of hydration and the application of the same method of investigation to microscopic sections of cement clinker made it possible to clear up also the constitution of the clinker.

The Qualitative Composition Of The Clinker: The principal component parts of Portland cement clinker are calcium oxide, silica and alumina. The possible compounds that these may form are calcium-silicates, calcium-aluminates and alumina-silicates, or finally even double-compounds of these salts. Alumina-

silicates may be left out of consideration from the very beginning, for they are known not to be acted upon by water; moreover, they are completely decomposed in the manufacture of cement. The question to be answered is, therefore, the following: What is the composition of the calcium silicates and calcium aluminates occurring in Portland cement and in what form are they contained in it?

As for the composition of the calcium silicates in question, it is evident that mono-calcium silicate can not be present, for the experiments with this compound taught that it hydrated extraordinarily slowly and, besides, formed products that could never be discovered in normal cements. On the contrary, all observations led rather to the conclusion that Portland cement clinker must contain a calcium silicate higher in lime than the former, as hydrating cements showed invariably the same microscopic picture as the fused lime-silica mixture which contained at least



Belt of colloids surrounding each grain of cement, consisting of a hyaline mass, which becomes less translucent in time on account of the water being used in decomposing the surface layers of the cement grains as well as in forming crystals of hydrated alumina compounds or of calcium hydrate.

two molecules of calcium oxide to one of silica. Now, the experiments made by Day & Shepherd show plainly that the only compound in question is the di-calcium silicate, for they demonstrated that in the presence of a sufficient amount of lime and at temperatures surpassing 1400 centigrade only di-calcium silicate is able to form out of a lime-silica mixture, and, in fact, these two conditions invariably exist in the manufacture of Portland cement.

As described in the first part of this paper, the di-calcium silicate is converted into mono-calcium-silica-hydrate. The calcium hydrate liberated in the process of hydration explains the presence of the hexagonal crystals in hardened cement.

The composition of the calcium aluminates contained in Portland cement clinker can be deduced with great probability from the observations made during the study of the process of hydration. In hardening cements, crystals of hydrous tri-calcium aluminate were invariably observed; consequently the clinker itself must contain tri-calcium aluminate. If it had been formed only in the course of the process of hydration from aluminates lower in lime, a colloidal mass and other crystalline products containing alumina would have been precipitated, in accordance with the results recorded in the first chapter, which however, were never observed at hardening Port-

land cements; and aluminates higher in lime than the tri-calcium aluminate, are unknown.

These reflections lead to the conclusion that Portland cement clinker contains di-calcium silicate and tri-calcium aluminate. It remains to decide, whether both compounds are separate units or whether they form a calcium-aluminum-silicate. There are a number of reasons against the assumption of a double-compound.

In the first place, the hydration of normal Portland cement offers the same features as that of a mixture of di-calcium silicate and tri-calcium aluminate. Furthermore, the microscopic examination of thin sections of clinker hitherto revealed only two kinds of crystals. The four different crystal formations described by Le Chatelier and Toernebohm, namely, alite, belite, felite and celite can easily be reduced to two, as, according to the statements of these experimenters, the first three resemble one another very much.

A third point against the hypothetic double-compound is the behavior of the iron cements during hydration, which are perfectly analogous to alumina cements as far as their hydraulic properties are concerned. The features accompanying the hydration of iron cements plainly show that the calcium ferrite is not combined with calcium silicate. If they contained a calcium-iron-silicate, the calcium ferrite would not remain perfectly indifferent during the hardening process, but would be decomposed by the water, as the other constituent of the compound is acted upon very distinctly. On account of the resemblance between the chemical actions of iron and aluminum compounds, the rules for iron cements are applicable most likely also to alumina cements.

These considerations made the separate existence of the two salts in cement clinker very probable. The results of a series of experiments on microscopic sections of clinker furnished a further proof for the correctness of this assumption. The thin sections were prepared from commercial cement clinker of fair quality by means of kerosene. Microscopic investigation proved them to be of crystalline structure; however, distinct crystals could not be seen. Several of the sections were treated with a solution of patent-blue in water. The dye was allowed to act upon them for 5 or 10 minutes and was then washed off; hereafter the preparation was dried with alcohol and ether. This procedure did not stain the microscopic sections uniformly; on the contrary, imbedded in an uncolored crystalline mass, a few single crystals of intense blue color, all resembling one another very closely, became visible here and there. Several other preparations were stained with methylene-blue in dilute acetic acid for a short time, then washed with water and dried in the air. Now the larger portion of the sections was colored distinctly, while only few crystals, disseminated irregularly throughout the mass, remained colorless. The stained crystals possessed all the same long shape. If the preparations were treated with Canada balsam, the color became even more visible. These two kinds of microscopic sections, the one stained with patent-blue and the other with methylene-blue, plainly show that Portland cement clinker is composed mainly of silicate crystals, which are free of alumina, and, in addition, of a small amount of alumina compounds free of silica, for acidous methylene-blue stains only the former and patent-blue exclusively the latter.

The Quantitative Composition Of The Clinker: After having recognized Portland cement clinker as a conglomerate of di-calcium silicate and tri-calcium

aluminate, it remains to show in what proportions both components are present. This information can be obtained through a contemplation of the average composition of the German and French Portland cements recorded in the following table:

Ingredients	in Germany %	in France %
CaO	58,22—65,59	58 —67
SiO ₂	19,80—26,45	20 —26
Fe ₂ O ₃	2,19— 4,47	2 — 6
Al ₂ O ₃	4,16— 9,45	5 —10
MgO	2,89	0,5— 3
K ₂ O+Na ₂ O	0,19— 2,83	
SO ₃	0,19— 2,19	0,5— 2

Loss at red heat: 0,26—2,67%.

Insoluble Residue: 0,12—2,38%.

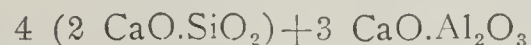
In order to arrive at the mean percentage of calcium oxide, silica and alumina contained in clinker, the average of the foregoing figures was taken, whereby potassium, sodium and sulphuric acid were neglected on account of the low percentage present. The magnesium oxide was added to the calcium oxide and the iron oxide to the alumina. Thus a normal Portland cement contains on an average:

CaO	64%
SiO ₂	23 "
Al ₂ O ₃	11 "
Loss at red heat, etc.	2 "

By dividing with the molecular weights, the number of molecules of calcium oxide, silica and alumina prove to be the following:

11,4 CaO
3,8 SiO ₂
1 Al ₂ O ₃

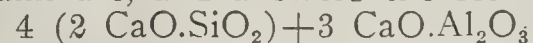
This result corresponds almost exactly with the formula:



which contains

11 CaO
4 SiO ₂
1 Al ₂ O ₃

Hence, Portland cement clinker contains four molecules of di-calcium silicate to each molecule of tri-calcium aluminate, and answers the formula:



According to these calculations, it can not contain an appreciable amount of calcium oxide in the uncombined state.

III. The Functions of the Two Components of Clinker During the Burning and Hardening Process.

The two components of Portland cement clinker, the di-calcium silicate and the tri-calcium aluminate, perform during the burning and hardening of cement, certain definite functions.

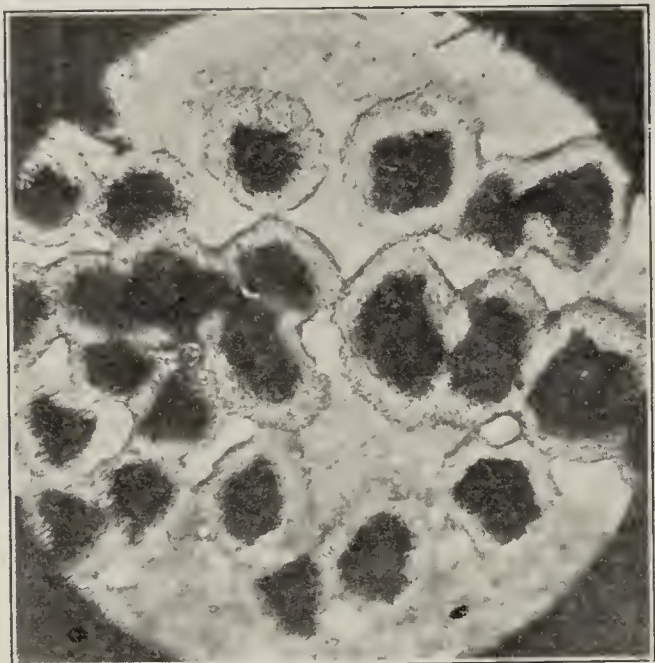
The di-calcium silicate is the cause of the hardening during the process of hydration; it is well known to gain considerable strength even by itself. The hardening is started by the formation of the described fine needle-crystals, which are completely interlaced, and by the colloidal mass, which cements together all bodies embedded in it. The ability of the needle-crystals to interlace remains the same in the presence of sand, as stated in the first chapter.

The tri-calcium aluminate does not contribute to the hardening, for it does not harden alone, if mixed with water. That it does not take a part in the hardening process, follows likewise from its analogy to iron cements, that obtain high strength without any assistance from the calcium ferrite. However, the tri-calcium aluminate performs another important

office during the burning and hydration of cement which will be demonstrated by the following experiment.

Di-calcium silicate was fused together with a small amount, about 5%, of tri-calcium aluminate. This admixture lowered the melting point considerably and now, upon cooling, the fused mixture was not seen to disintegrate into a solid portion and a powder, which the di-calcium silicate invariably did, but it remained a perfectly homogeneous body. After having been mixed with water, the ground product hydrated much faster than the pure di-calcium silicate. This showed very plainly, in the first place, that the admixture of tri-calcium aluminate acted as a flux, furthermore, that it prevented disintegration of the fused product, and finally, that it accelerated the hardening process of the di-calcium silicate with which it was mixed. Additional experiments proved that admixtures of calcium chromites and calcium ferrites acted in a similar manner.

The same duty that the tri-calcium aluminate fulfilled in the last experiment, it performs also in Portland cement proper, in which it acts likewise as flux. Furthermore the fact that the cooling vitrified product does not disintegrate, is due to its contents of tri-calcium aluminate. Moreover, the presence of the



Crystals begin to form within the colloids coating the cement grains, as it were, with a film of glue. The cement is still plastic, but the colloids become less translucent.

latter in cement quickens the hardening of the di-calcium silicate in cement and hereby renders the cement suitable for practical purposes. This important function of the tri-calcium aluminate follows also from the observation that the quick-hardening cements contain more alumina than the slow hardening.

Summary.

Until very recently, the investigation of the process of hydration and of the constitution of cement did not yield positive results; only the microscopic researches by Le Chatelier, Ambrohn and others began to clear up the subject. Le Chatelier demonstrated that clinker contained crystalline compounds and Ambrohn proved that, during the hydration of cement, well-defined bodies were formed. In both instances, however, the chemical nature of these compounds remained unexplained.

The present paper tried to accomplish the final solution of the problem.

It was found that the purely crystallographic and microchemical descriptions of the observed bodies,

customary so far, were insufficient; these methods, therefore, had to be supplemented by a staining process. By subjecting the preparations to a number of dye-solutions, it was easy to distinguish with absolute certainty the various formations containing alumina, calcium oxide and silica. The reagent for alumina was patent-blue, that for calcium oxide alcoholic anthrapurpurine, while free amorphous silica (not quartz) was stained by neutral methylene-blue. Combined silica, as contained in the silicates in question, could be detected by a dilute acetic acid solution of methylene-blue.

With a view to elucidating the nature of the bodies formed during hydration, the process of hydration was observed at a number of fused products of known composition, which were stained while hydrating or upon completion of the process. The preparations thus examined consisted of: Cements, calcium aluminates, calcium silicates, calcium chromites and calcium ferrites. The result was the following:

1. The well-defined fine needle-crystals observed in hydrating calcium silicates are composed of mono-calcium silica hydrate. They form during hydration of calcium silicates as well as in a mixture of calcium hydrate and silica hydrate. Calcium silicates higher in lime than the mono-calcium silica hydrate can not form in aqueous solutions, according to Jordis and Kanter. The needle crystals are stained by anthrapurpurine, but not by patent-blue.

2. The colloidal mass contained in hardening cement is likewise mono-calcium silica hydrate; it forms under the same conditions as the fine needle-crystals; it is not colored by patent-blue, hence is free of alumina. Acidous methylene-blue precipitates silica which is stained at once. The only difference between the colloids and the needle-crystals is the larger percentage of water of the former. Most likely calcium hydrate is precipitated on its surface.

3. The large hexagonal crystals consist of calcium hydrate. They are stained exclusively by anthrapurpurine and are formed from pure solutions of calcium hydrate.

4. The small hexagonal plate-crystals are hydrous tri-calcium aluminate. They are not colored by methylene-blue, however very strongly by patent-blue. That they contain alumina follows likewise from their analogy to chromium cements, which form the same plate-crystals upon hydration; the latter, however, are green on account of their contents of chromium. The quantitative composition of the plate-crystals has been cleared up by experiments with hydrating calcium aluminates; only fused products answering the composition of the tri-calcium aluminate form exclusively plate-crystals during hydration; all mixtures lower in lime show, in addition to the former, colloidal alumina hydrate. Higher-limed aluminates than the tri-calcium aluminate do not exist.

The constitution of the clinker could likewise be solved, with the aid of the results obtained during the study of the process of hydration. It was, furthermore, cleared up through examinations on microscopic sections of clinker subjected to the staining process. The results obtained made it very probable that Portland cement clinker represented a conglomerate of di-calcium silicate and tri-calcium aluminate in the proportions of four molecules of the former to one of the latter. The qualitative composition of the two components was ascertained by observations on hydrating products and by comparison with results obtained by other experimenters; the amount in which they existed in clinker could be calculated from the average percentage of the various elements occurring

in standard Portland cements. That Portland cement clinker represented a conglomerate and not a compound of the two components could be established beyond doubt through the examination of the microscopic sections. The staining process plainly revealed two different kinds of crystals, of which one contained alumina and no silica and the other silica, but no alumina. Uncombined calcium oxide could, according to my calculations, not be present in appreciable amounts. The few crystals of calcium hydrate to be observed during the process of hydration originate from decomposed di-calcium silicate.

The peculiar functions of the two components during the burning and hardening of cement proved to be the following: The hydrating di-calcium silicate alone brought about the setting and thus started the hardening process. The tri-calcium aluminate, however, was found not to contribute anything towards the setting and hardening. In the same way, iron cements hardened well, without any assistance by the iron compounds which did not even hydrate. The part taken by the tri-calcium aluminate was illustrated by an experiment in which di-calcium silicate was fused together with a small percentage of tri-calcium aluminate. The lesson learned from it was that the aluminate decreased the melting point of the cement considerably and that its presence in cements prevented disintegration and, furthermore, accelerated the process of hydration.

REMARKS BY DR. W. MICHAELIS, SR.

The foregoing essay by S. Keisermann undoubtedly contains an entirely novel method of progressing in the research of the composition of cement clinker and of the hardened cement. For the introduction of this staining process into the microscopic investigation of cement the author certainly deserves great credit.

The results arrived at are briefly the following:

1. Portland cement clinker represents most likely a conglomerate of four molecules of di-calcium silicate to one molecule of tri-calcium aluminate. Free lime can not be contained in it in appreciable quantities.

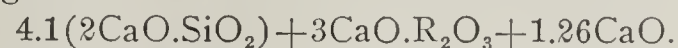
2. The fine needle-crystals formed in the course of the hydrating process are principally composed of mono-calcium-silica-hydrate.

3. The colloidal mass consists likewise of mono-calcium-silicate-hydrate.

4. The tri-calcium-alumina-hydrate does not contribute anything to the setting and hardening of the cement.

In reply to these statements I wish to make the following remarks:

In the first place, I consider it very likely that the author's views are correct with regard to the non-existence of double compounds in Portland cement clinker. This same opinion was published in my paper "The Properties and The Hardening Process of Portland Cement" in 1887, in which Portland cement was described as a product obtained by decomposition of alumina-silicate by means of lime at high temperatures, hence, as a mixture of calcium compounds of silicic acid, aluminum acid and iron acid. However, the formula advanced by Keisermann for the chemical composition of Portland cement has to be changed, in my mind. Accurate calculation of the Portland cement of average composition, as suggested by him, yields the following figures:



In the following I add to Keisermann's cement of average composition five analyses of Portland cements of various origin, namely:

1. Cement with lowest limit of lime according to the latest rules.

2. Cement containing the lowest possible amount of silica and highest percentage of alumina.

3. Cement, Keisermann's example with a medium percentage of alumina.

4. Cement "Lebbin," very low in alumina and high in silica.

5. Cement of the Stettin factories.

6. My fused Portland cement containing the highest limit of calcium oxide.

The table gives the composition of these cements in per cent. The figures given in parenthesis indicate the ratio of the molecular weights.

	1	2	3	4	5	6
SiO ₂	= 22.8 (38)	19.86 (331)	23.00 (383)	25.61 (427)	22.20 (37)	20.78 (349)
Al ₂ O ₃	= 7.2 (7)	9.45 (93)	7.12 (70)	3.78 (37)	6.12 (6)	5.83 (57)
Fe ₂ O ₃	= 4.8 (3)	4.47 (28)	3.68 (23)	2.05 (13)	3.20 (2)	2.72 (17)
CaO	= 57.2 { (109)	58.22 { (1120)	61.20 { (1163)	65.24 { (1188)	64.40 { (118)	69.05 { (1256)
MgO	= 2.8 {	3.20 {	2.80 {	0.93 {	1.20 {	0.92 {
CaSO ₄	= 5.2	4.80	2.17	2.38	2.88	0.70
Alkalies						
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The hydraulic modulus of these cements, that is to say, the ratio of the calcium oxide to silica plus alumina plus iron oxide is the following:

1.7 1.72 1.8 2.07 2.04 2.35

According to Keisermann, the formulae for these six cements would have to be written:

No. 1.—3.8	(2CaO.SiO ₂) + 3CaO.R ₂ O ₃ + 0.3	CaO + Rest
" 2.—2.375 (	") +	" + 0.718
" 3.—4.1 (	") +	" + 1.26
" 4.—8.54 (	") +	" + 2.11
" 5.—4.625 (	") +	" + 2.51
" 6.—4.716 (	") +	" + 4.54

In 1895, I explained in a paper on the "Behavior Of The Hydraulic Cements In Sea-Water," why the tri-calcium aluminate could not be contained in normal Portland cement, or at least not in noticeable amounts, namely because it yields invariably blowing cement in the same way

as the tri-calcium ferrite and the hypothetical tri-calcium silicate. Therefore, the aluminate and ferrite lower in lime, namely 5CaO.3Al₂O₃ and 5CaO.3Fe₂O₃ must be considered to prevail in Portland cement clinker.

Furthermore, it has been established beyond doubt that

Portland cement contains free lime in solid solution dissolved in the di-calcium silicate.

Schott verified in his recent paper my statement, made long ago, that clinker with half a molecule of free lime yielded excellent cement. In addition to this, he demonstrated that even much more lime could safely be dissolved by the di-calcium silicate, for he proved that at least 4% of alumina were required in order to transform the unstable hypothetical tri-calcium silicate into a sound hydraulic product. This means, that a sound di-calcium silicate, containing 0.73 molecules of calcium oxide in solution, was formed, if we assume tri-calcium aluminate to exist in cement clinker, or that a sound di-calcium silicate with 0.85 molecules of calcium oxide in solution was present, if the next lower aluminate, the $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$, is believed to be contained in the calcined cement.

Hence, Keisermann's calcium silicate stained by methylene-blue was invariably di-calcium silicate carrying uncombined lime in solution. The tri-calcium aluminate, which crystallizes in hexagonal plates, is consequently always formed by the reaction between the lime-solution and the calcium aluminate solution, which both necessarily result immediately upon addition of water to cement.

Whenever the formation of tri-calcium aluminate in clinker surpasses a certain limit, blowing cement is the result, as the formation of the tri-calcium alumina-hydrate (with 10 molecules of water according to Gino Gallo and with 8 according to Michaelis) is too rapid in this case.

In my opinion the formulae for the foregoing six cements must be written as follows:

No. 1.—11.4	($2\text{CaO} \cdot \text{SiO}_2 + 0.43$	CaO)	+ $5\text{CaO} \cdot 3\text{R}_2\text{O}_3$	+ Rest
" 2.— 7.125	(" + 0.86	")	+ " + "	
" 3.—12.3	(" + 0.63	")	+ " + "	
" 4.—25.62	(" + 0.40	")	+ " + "	
" 5.—13.875	(" + 0.83	")	+ " + "	
" 6.— 4.716	(" + 0.96	")	+ $3\text{CaO} \cdot \text{R}_2\text{O}_3$	+ "

In the case of cement No. 6, the fused Portland cement, which possessed the highest strength and was perfectly sound, I am compelled to assume the existence of a tri-calcium aluminate, as otherwise more than one molecule of calcium oxide would be dissolved in the di-calcium silicate.

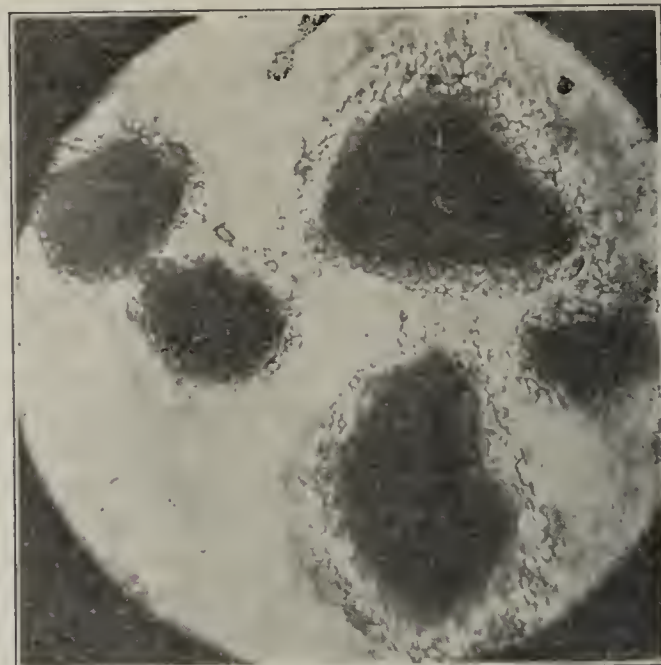
S. B. Newberry succeeded in obtaining almost pure $2\text{CaO} \cdot \text{SiO}_2 + 1\text{CaO}$, which, if well fused, yielded also a sound cement.

As to Keisermann's second statement it does not seem to me sufficiently proven that the fine needle-crystals are exclusively calcium-silica-hydrate. He does not mention with a single word zeolite crystals, nor crystals of calcium sulphate or calcium sulphoaluminate; this is certainly surprising as the contents of potassium of Portland cement makes the formation of up to 10% of apophyllite possible.

His third statement to the effect that the colloidal mass consists of calcium-silica-hydrate, plainly shows that Keisermann is not aware of the fact that calcium-hydrate does not crystallize under all circumstances, but mostly occurs as colloid, as "gel," just as well as silica-hydrate, alumina-hydrate and iron-hydroxide. The colloidal mass, therefore, contains certainly colloidal calcium-hydrate in every instance, from which, under favorable conditions, a small amount of calcium-mono-hydrate may crystallize. Also part of the calcium aluminate and calcium ferrite occur as colloids.

The fourth deduction made by Keisermann, namely that alumina compounds do not contribute anything to the hardening process is astounding in the face of the fact

known for the past fifty years that the sound calcium aluminates harden very energetically and obtain a strength equal to the best Portland cements. As to calcium ferrite, F. Schott, O. Schott and myself made observations dia-



The colloidal mass in a later stage, showing the colloids hardened by loss of water. The water has been consumed in further decomposing the cement grain and in building up the numerous crystals imbedded within the colloids.

metrically opposite to those of Keisermann. My first book "The Hydraulic Mortars etc.," published in 1869, contains already the statement that calcium ferrites are completely decomposed by water; those low in lime react

very slowly, of course. More than twenty years before Le Chatelier, Schott and I burnt excellent Portland cements in which the alumina was completely replaced by iron oxide or manganese oxide. Moreover, the larger amount of calcium hydrate given off by the hardening cements of the latter class proves that the calcium ferrite is readily acted upon by water. The ferrite occurring in Portland cement has, in my opinion, the composition $3\text{CaO} \cdot 2\text{Fe}_2\text{O}_3$.

The conclusions to be drawn from Keisermann's research work lead again to my very first statements about the nature of Portland cement clinker, which were summed up in the book mentioned in the foregoing as follows:

"A large number of cements of good reputation show ratios of the molecular weights lying between the limits of 80 silica to 15-25 alumina plus iron oxide to 210-230 calcium oxide. Under the assumption that di-calcium silicate, tri-calcium aluminate and tri-calcium ferrite are formed, 80 molecules of silica call for 160 molecules of calcium oxide, and the 15-25 molecules of alumina plus iron oxide require 45-75 molecules of calcium oxide, hence on an average: $80 \text{SiO}_2 + 20 \text{R}_2\text{O}_3 + 220 \text{CaO}$. As it is impossible at this time (in the year 1869, when the book was written) to ascertain the composition of the clinker by direct methods, a similar formula, giving merely the ratio of the molecular weights of the various ingredients, deserves on account of its simplicity, to be preferred to all others."

$80 (2\text{CaO} \cdot \text{SiO}_2) + 20 (3\text{CaO} \cdot \text{R}_2\text{O}_3) + \text{Rest}$.
yields a Portland cement of the following composition:

(In this calculation the 20 molecules of sesqui-oxides, R_2O_3 , have been assumed to consist of 15 molecules of alumina and 5 molecules of iron oxide; and magnesia, gypsum and alkalis have been figured to amount to 4% altogether.)

Silica	23.69%
Alumina	7.55 "
Iron Oxide.....	3.95 "
Calcium Oxide	60.81 "
Rest	4 "

100.00%

$$\text{Hydraulic Modulus } \frac{60.81}{35.19} = 1.725$$

Hence 1.725 parts by weight of calcium oxide to 1 part by weight of silica, alumina and iron oxide combined.

This composition represents the lower lime-limit in the definition of Portland cement, according to the latest rules.

So $(2CaO.SiO_2) + 15 (3CaO.R_2O_3) + 25 CaO$.
or in modern writing:

$16 (2CaO.SiO_2 + 0.3625CaO) + 5CaO.3R_2O_3 + \text{Rest}$.
yields a cement of the composition:

Silica	23.76%
Alumina	6.09 "
Iron Oxide.....	2.37 "
Calcium Oxide	63.78 "
Rest	4 "

100.00%

$$\text{Hydraulic Modulus } \frac{63.78}{32.22} = 1.98$$



Two grains of cement strongly magnified. They are connected by a colloidal zone that gradually decreased in volume upon drying out. In the present stage it forms a solid bridge between the grains which it glues or cements together. Within the hardened colloids, various kinds of minute crystals can be discerned.

At that time Portland cements did not contain as much lime on an average, as nowadays; it was, furthermore, unknown that di-calcium silicate could dissolve considerable quantities of calcium oxide.

Finally, I find it necessary to make opposition to several statements by Keisermann concerning quotations from my publications.

If Keisermann writes, I declared a process of crystallization, if such a thing would ever occur in hydrating ce-

ments, (I always knew that crystallization took place) to be of no effect upon the hardening and to be even harmful, he certainly misunderstood the meaning of my words. The idea they conveyed was that formation of crystals was harmful to the cement as a water-mortar and limited its durability in water, because the crystals interrupted the coherence of the colloids and admitted the solving agents, water and salt-solutions, into the interior, by way of the planes of contact between crystals and colloids.

If he, furthermore, states: "In his paper 'The Hardening Of Cement Under Water,' 1909, Michaelis declared the needle-crystals to be composed of calcium hydrate, but denied that they contributed to the hardening," he does me a great wrong, for this paper says literally, after the formation of the needle-crystals and plate-crystals has been described and illustrated by cuts:

"This is as far as the process of crystallization goes, which is identical with the setting and hardening process of gypsum. By this process setting and hardening of a cement may possibly be effected, but by no means can a hydraulic cement, that is to say a water-resisting mortar, be formed in this way, because the water surrounding a mortar made up merely of inter-locking crystals, as in the case of hardened gypsum, is able to penetrate the hardened cement at all times. The water, therefore, would be in a position to soften, dissolve and completely destroy the mortar."

Keisermann, furthermore, does not know that I belong to those experimenters who, long ago, declared the tri-calcium silicate not to exist and who assumed part of the lime to be in an uncombined state dissolved in the clinker. He seems to have read only a very small portion of my more than 100 publications on hydraulic cements.

Besides, puzzuolanas do not harden because they contain uncombined silica, which would readily combine with lime (solutions of sodium carbonate extract always only very small amounts of silica), but because the zeolites which they contain exchange their bases for the calcium hydrate with which the puzzuolanas are mixed and thus form new calcium zeolites and colloidal calcium-silica hydrate.

On the whole, Keisermann verifies my theory completely. However, a more thorough study of my publications would enable him to gain the correct views about my conception of the nature of the hardening process and of the constitution of cement clinker, which differ widely from those he published in the introduction to his paper.

EXAMPLES OF SIMPLE AND EFFICIENT CEMENT AND STEEL FIREPROOF CONSTRUCTION.

By H. M. Naugle.

There is no branch of the building trades, steel not excepted, which can show such a rapid development in a similar period of time as that of the cement worker's. Hardly a week passes which does not chronicle the discovery of some new method of applying cement to building operations. The development of those methods is governed by the progress made in devising the forms necessary to permit the use of cement in the various types of construction.

The system described here is one in which the frame of the structure is made to serve as a combined form and reinforcement, resulting in a fireproof structure which possesses all the good qualities of a massive skyscraping office building. To the discerning reader

the advantages of this system will immediately suggest themselves.

Metal Lumber and Cement Construction.

The cottage illustrated in Figs. 1 and 1 A consist of an eight room building of story and a half in height with cellar under whole area. Building is constructed with Terra Cotta exterior walls on which is supported metal "I" joists and channel rafters. The joists consist of 3" (3½ lbs. per lineal foot) Berger Metal lumber sections spaced 16" center to center. The

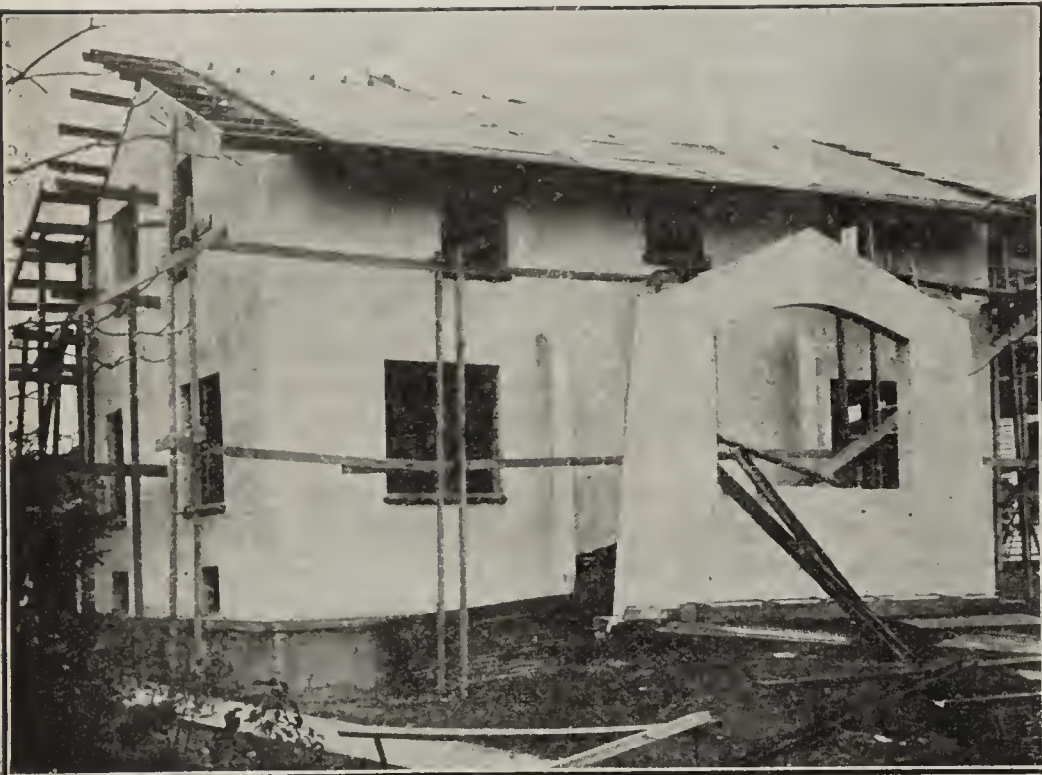


Fig. 1.—Albert Baxter's Cottage.

undersides of joists are provided with prongs punched from flanges which serve as a means of securing expanded metal lath to same on which ceiling plaster is applied.

The roof is constructed with 5" 1.8 pounds channel rafters spaced 16" center to center and diagonally bridged as illustrated in cut. On top of these rafters is applied Ferro Lithic interlocking steel plate, the top of which is covered with a ½" concrete slab. This slab consists of one part cement, 2½ parts sand and three parts fine gravel such as were passed through a ½" ring.

The finished flooring or wearing surface is applied to metal joists by nailing a wood block directly through the webs of same as illustrated in Fig. 2. Joists are diagonally bridged with 1" No. 18 gauge galvanized

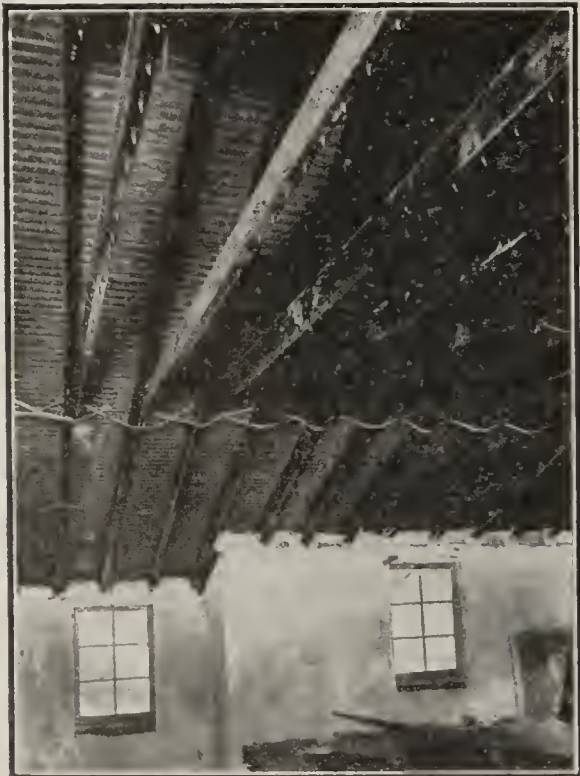


Fig. 1A.—Interior View.

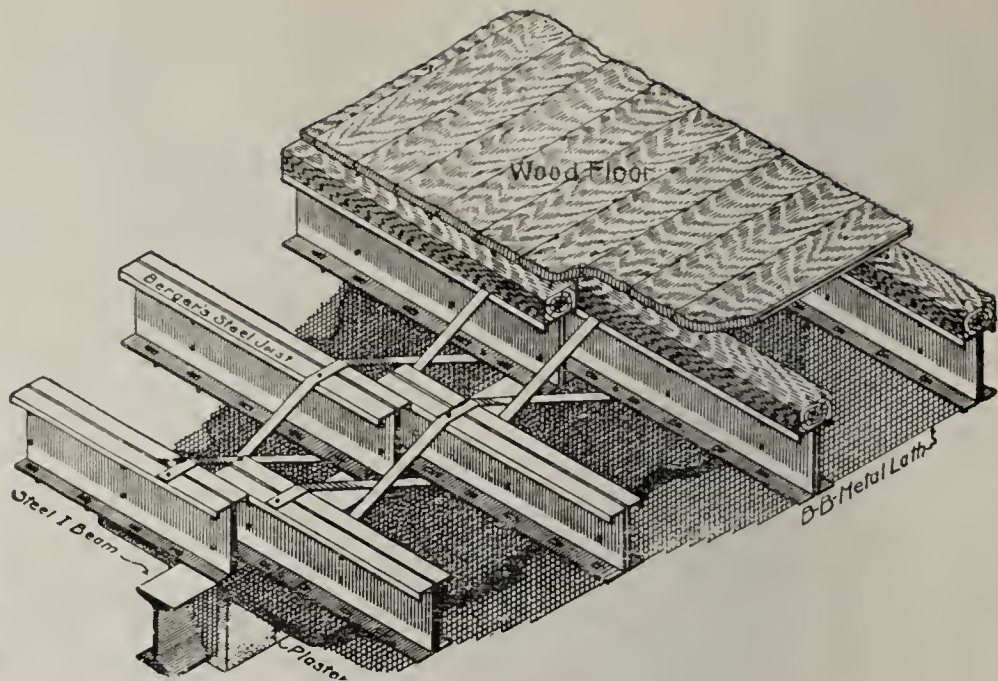


Fig. 2.—Showing Construction of Floor.

bridging, same being secured by means of nails driven through the webs and furnished in 10' lengths. This bridging is in tension and therefore very securely and quickly applied, bridging being spaced about every one-third span of joists.

The particular feature in the construction of this building is that the owner Mr. Baxter, is the contractor, and by the use of these joists and metal lumber sections in the interior construction, was able to erect the building absolutely fireproof at a cost almost equal to the ordinary wood construction with brick exterior walls.

This is due to the fact that all members were cut to the exact length, and furnished with an erection diagram such as is provided in rolled steel construction.

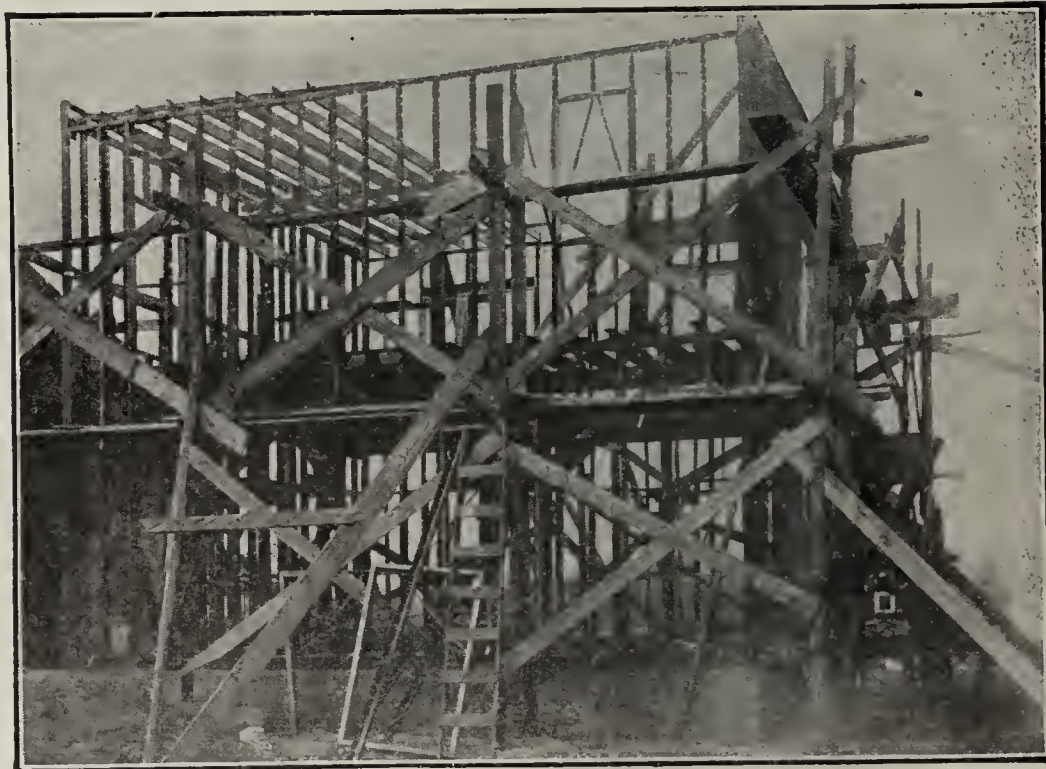


Fig. 3.—Construction View of Residence of Arthur Sanford.

By means of these diagrams it is possible to reduce the labor cost of erection sufficiently to offset the increased cost of the metal lumber over wood lumber.

The outside walls of this building are finished in Stucco with cement plaster. The plaster consists of one part cement, two parts sand and ¼ part lime and sufficient wood fibre to strengthen the gauge of the scratch coat, the second or finish coat being applied after the scratch coat has set sufficiently to receive same.

The building in question was designed by Architects Spencer & Powers with the view of obtaining information and keeping an accurate cost on the construction of a fireproof cottage.

The residence illustrated in Fig. 3 is constructed throughout with metal lumber as a structural material. All studs, rafters, joists, bridging, lath, crowning members track, wall ribbons, sills, lintels, etc., are of metal of various sections instead of wood, the construction being carried out along the same lines as the ordinary wood balloon frame construction.

The method of procedure in the erection of this building was to erect a scaffold around the exterior which was sufficiently rigid to permit of the metal studs being tied to same while they were being plumbed and lined. This scaffold also served the purpose of applying lath to the exterior studs, and in turn



Fig. 4.—Fabricating Metal Lumber for Unit Erection.

the cement plaster on the exterior, all members having been provided with prongs punched from flanges, and metal lath is very easily applied to side walls, partitions, ceilings and roof.

Some of the particular advantages obtained in this class of construction aside from the fireproof qualities are that there is no chance for shrinkage of the lumber thus eliminating objectionable cracks in the interior



Fig. 5.—Metal Lumber Used at Lima, Peru, S.A.

plaster and the possibility of door and window casings becoming warped or out of line as is often the case in wood construction.

Another strong point in favor of the construction is the elimination of cracks in the exterior cement which is Stuccoed and water proofed with some high grade water proofing compound. The exterior wall construction consists of channel studs on which expanded metal lath is applied to the outside flanges. To the outside of exterior lath is applied one coat of cement plaster. After this has set eight or ten hours a coat of back plaster is applied to the inside of the exterior lath. By this means the exterior lath was wholly imbedded in cement plaster and thus thoroughly protected from corrosion. To the outside or scratch coat is applied the Stucco finish coat, all plaster used consisting of one part cement, two parts sand and $\frac{1}{2}$ lime.

After back plaster was applied to the exterior lath, the interior lath was then secured to the studs and same plastered as in the ordinary wood construction.

A residence constructed in this manner is absolutely rigid, fireproof, vermin proof, cool in summer and warm in winter.

All metal lumber sections are riveted together, and the super-structure is secured to the reinforced concrete foundation by means of anchor bolts, thus making it practically impossible for the building to vibrate or to be destroyed by the elements, either fire or wind. Metal lumber sections are given two coats of specially prepared paint, hand dipped, and have been used extensively in this class of construction without any deteriorating effect from corrosion.

The building illustrated in Figs. 4, 5 & 6 is constructed of metal channel studs under the supervision of C. Leon Carty, Engineer of Lima, Peru, S. A.

Mr. Carty developed the new system of erecting



Fig. 6.—Completed Building.

metal lumber sections as is illustrated in cuts. This is accomplished very easily as it is not a difficult matter to fabricate the members on the floor and erect same to a vertical position before the plaster is applied. The finished view of the building in Fig. 6 shows what can be accomplished by the use of the material by inexperienced labor, in charge of a competent engineer, even though he never had previous experience with the use of metal lumber.

This building has been constructed with a view of having same earthquake as well as fireproof. A similar building erected in Cartago, Costa Rica is the only one standing after the earthquake which occurred there a few months ago, thus proving the efficiency of the material when subjected to severe strains as are occasioned in earthquakes and fire.

UNITED STATES SILICA CO.

Probably one of the most interesting features of the Chicago Cement Show will be the exhibit of the United States Silica Company, of Chicago. This Company has for some time been encouraging the use of their Crystal Silica in cement construction and the effects produced by its use are so meritorious that it would seem to be to the advantage of all interested in concrete construction to investigate their material and promote its use.

There is no question about the unsightly surface of most concrete work and anything that will tend to improve its appearance should be heartily encouraged.

The exhibit will show a doric temple, the columns constructed of Crystal Silica and white cement, interior art mantles, statuary building blocks and a general line of forms built or faced with Crystal Silica, grey and white cement.

There are many authorities who believe that Crystal Silica is too fine for the ordinary concrete mixture, and while this may be true to some extent in the heavy, rough concrete work, it does not apply to the facing of such work or to the lighter structures built for artistic effect.

In a very attractive little booklet published by this Company, and which will be distributed at the Cement Show, some interesting information is given regarding the production of Crystal Silica and the proper manner in which to use it, showing attractive buildings in which it has been used. Quite a fund of useful information is contained about the proper manner of facing, washing down, and water-proofing concrete work.

The exhibit will be in space 66 and we prophesy that it will be an attractive and well patronized booth.

THE HANDLING OF CONCRETE DURING COLD WEATHER.

By J. H. Chubb.

The general practice of a few years ago was to bring all concrete work to an abrupt close at the approach of cold weather, and concrete structures that could have been completed and in use long before work was again resumed were permitted to remain in their incomplete condition throughout the winter. Of late years, however, conditions have changed somewhat, and a large amount of concrete work has been successfully carried on at the season, during which a few years ago contractors were idle, and would have experienced considerable difficulty in obtaining permission to proceed with the work had they cared to do so.

The satisfactory results obtained where the work has been properly handled have served as an incentive for increased activity during the winter months, but we wish to caution against the growing disregard of the importance of properly placing and protecting concrete work in freezing weather. Serious accidents and examples of unsatisfactory work due to damage done by freezing are far too numerous, and the practice of mixing, placing and protecting concrete in cold weather in the same manner as in warm weather is most certainly to be condemned.

Just what should be considered good practice in handling concrete during freezing weather is a question upon which there is considerable difference of opinion amongst engineers and contractors. That low temperatures materially retard the hardening of concrete is admitted by all, and while there is some difference of

opinion as to the ultimate effect of freezing upon Portland cement concrete, the general opinion is that freezing will not damage concrete that has had a chance to harden under favorable conditions for from 24 to 48 hours. The freezing simply retards the process of hardening, which again proceeds under favorable conditions, and the concrete eventually obtains full strength.

On the other hand, concrete that is frozen before the action of hardening has started, is not apt to be permanently injured, if upon thawing, it is not again frozen until it has had a chance to harden sufficiently to withstand the action of subsequent freezing. But alternate freezing and thawing at comparatively short intervals, which allow the intermittent action of hardening, is very apt to damage concrete. It is this latter condition that almost always occurs in actual practice, and which makes it imperative to mix and place in such a manner as to insure proper hardening during the first few days.

Interesting and valuable experiments were conducted at the Watertown Arsenal some years ago, the results of which demonstrate very clearly the effect of low temperatures upon the strength of cements and cement mortars. Cubes of different mixtures were placed in a cold storage warehouse where some of them were subject to a temperature of 39 degrees F. and some to a temperature of 0 degrees F. Those subject to the lower temperature were mixed and modeled at a temperature below freezing. All cubes were subject to the temperature noted as soon after mixing as was practicable, and before being tested were kept at a temperature of 70 degrees for the number of days indicated. The results obtained on cubes composed of a 1-1 Portland cement mortar are tabulated below. Each strength shown is the average compressive strength in pounds per square inch of five 2 inch cubes:

D's at 0° F.	Days at 70° F.	Strength	Days at 0° F.	Days at 70° F.	Strength	Days at 39 F.	Days at 70° F.	Strength
5	1	287	5	7	846	15	0	1710
14	1	321	14	7	1000	31	0	1960
21	1	337	21	7	1010	60	0	2460
31	1	383	31	7	981	15	7	2710
60	1	416	60	7	981	31	7	2720
90	1	497	90	7	1010	60	7	3270

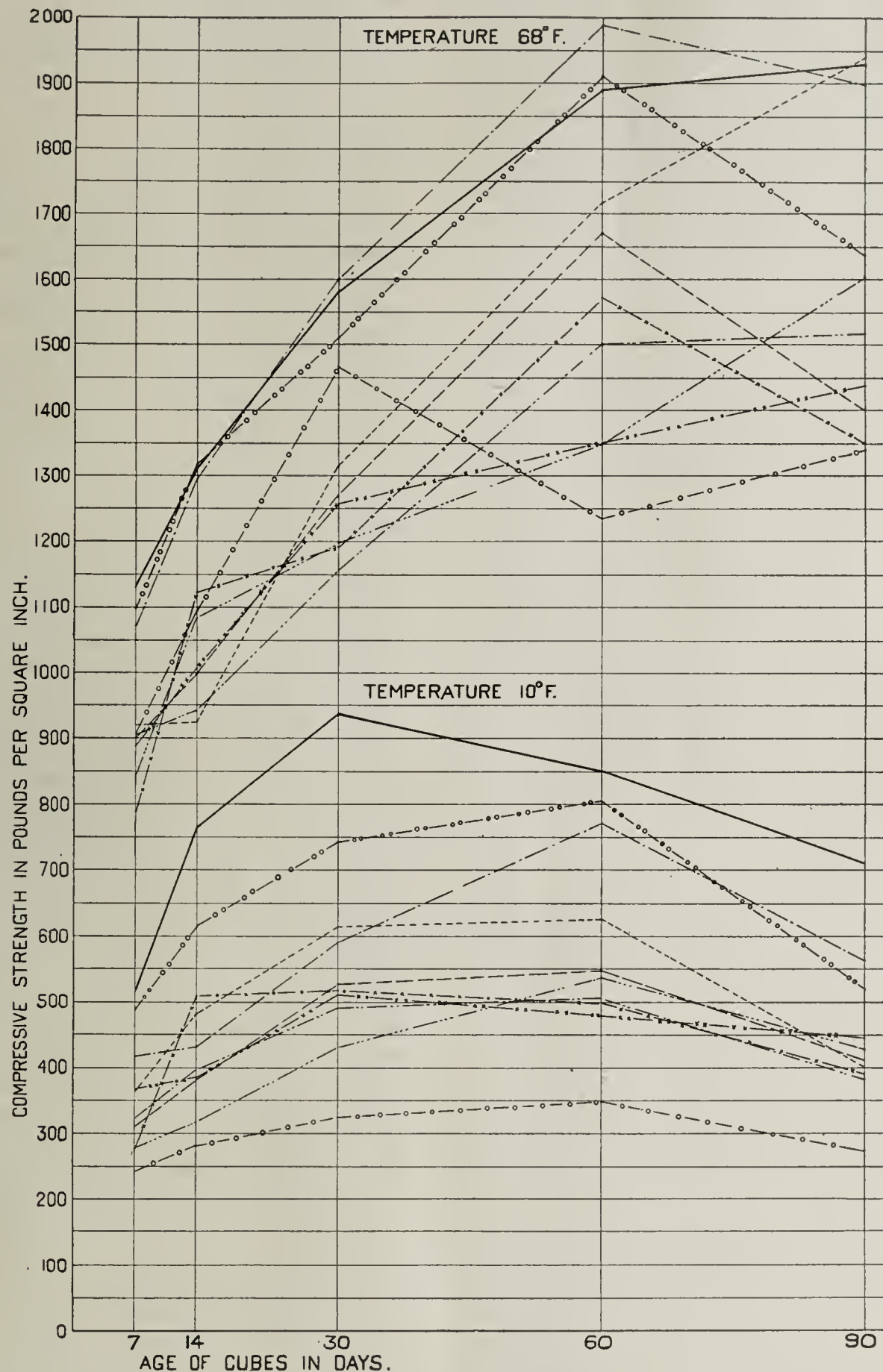
The results show quite plainly that during exceptionally low temperature the action of hardening is practically suspended and that a marked increase in age is accompanied by a comparatively slight increase in strength. Also that frozen concrete when subject to favorable conditions will show a marked gain in strength. It will be noted that all cubes are subject to a temperature of 70 degrees for 7 days show practically the same strength, irrespective of the length of time they have been frozen, and that 12 day strength, 7 days at 70 degrees and 5 days at 0 degrees, is over 70 per cent greater than the 91 day strengths, 90 days at 0 degrees and 1 day at 70 degrees.

The Universal Portland Cement Company during the past year conducted an extensive investigation of the effect of low temperatures on the strength of Portland cement concrete. Eight-inch cubes of a 1:2:4 concrete with ten different brands of American Portland cement were subjected to various temperature conditions at a cold storage warehouse and broken at different periods up to and including three months. The result obtained upon cubes of every brand stored at a temperature of about 70 degrees F., what might be termed normal or summer conditions, are graphically shown in the upper diagram, and the results on cubes stored at a temperature of 10 degrees F., winter conditions, in the lower diagram indicate the age in days

of the cubes when broken, and those along the left hand edge their compressive strength in pounds per square inch at each period. Each line in a diagram represents a different brand of cement, similar lines in each diagram showing the behavior of the particular brand under two different temperature conditions. The solid black line in each diagram represents the result obtained on the cubes made with Universal Portland cement, and shows for example, that those stored at a temperature of 70 degrees for 90 days developed a

sent the 7 day strength of specimens stored at 10 degrees F. for the period indicated.

A comparison of the two diagrams clearly indicates what a marked effect different temperature conditions have on the strength of Portland cement concretes. While under normal conditions an increase in age is accompanied by an increase in strength, especially at the short time periods, no such gain is to be expected during the time that the concrete is frozen. Similarity in the behavior of all brands of cement when subject



strength of approximately 1925 pounds per square inch, while those stored at 10 degrees F. for 90 days had a strength of about 710 pounds per square inch.

The cubes placed in cold storage were all left in the molds and subject to the temperature indicated as soon after making as practicable. These cubes were all stored at a temperature of between 50 and 60 degrees F. for 7 days before being tested, to give them sufficient strength to be readily handled and to make sure that they had been completely thawed out, so the results plotted in the lower diagram really repre-

to low temperatures is also to be noted.

These and numerous other laboratory results, together with those obtained in everyday practice, show the folly of attempting to carry on concrete construction during the winter months without taking proper precautions to counteract the action of freezing. A given amount expended in heating materials and protecting the work from freezing immediately after placing will be infinitely more effective than an equivalent amount of heat expended in attempting to hasten the hardening of concrete that has been mixed with cold

materials and subject during the next few days to unfavorable conditions.

A case is reported where it was possible to remove the forms from an upper floor concreted during favorable weather conditions late in April before those of the floor directly beneath, which was constructed during cold weather in February; yet the lower floor was subject to the same favorable weather conditions which influenced the hardening of the upper one, and was, in addition, nearly two months older. During the construction of an 8-story reinforced concrete building, where the work progressed at the rate of about two stories in three weeks, it was found necessary to use eight sets of floor forms. While they were concreting the lower three or four stories, the temperature was close to, but rarely went below freezing, and the contractors did not consider it necessary to heat materials or protect the work. During the concreting of the fourth story the weather turned exceptionally cold. The work was housed in with canvas, heated with salamanders and the water used for mixing concrete heated. An examination of the work showed that the concrete in the upper when but a week or ten days old, was stronger and better than in the lower floors, which were many weeks older. Had the contractor taken the precautions at the beginning that were taken later on, only about half as much lumber would have been required for forms, and the extra cost of handling the work would have been but a fraction of that for these additional forms.

As an example of the benefit to be derived from the proper handling of winter work the experience of a contractor during the construction of a reinforced concrete bridge will answer. The bridge consisted of three 3-centered arches having a clear span of 110 feet each. While the arches proper were being concreted the weather turned quite cold, from 12 to 15 inches of ice forming on the river. Nineteen days after the center span was concreted a warm rain set in, resulting in a flood which carried away the false work and centering for this span, but did not result in any damage to the bridge. The materials for the concrete were thoroughly heated, being delivered to the mixer at an average temperature somewhat above blood heat, and as soon as the concrete was deposited it was protected with a covering of tar paper and boards. The proper handling of the work in this case probably prevented the total destruction of the middle span when the forms were accidentally removed long before the intended time.

These and numerous other examples in every day practice clearly illustrate that winter work cannot and should not be handled in the same manner as summer work.

The proper precautions necessary to insure satisfactory results with concrete during freezing weather depends, very much, upon the class of construction, large plain mass work such as retaining walls and abutments, not requiring the same care and protection as thin walls, columns, beams and floor slabs. Elaborate and expensive plans for heating the materials and protecting the work have been constructed and successfully used on important work, but the additional equipment considered necessary for winter work is really comparatively limited, consisting simply of a sufficient amount of canvas for housing in or covering the work, salamanders or some other form of heaters for maintaining a temperature above the freezing point and some provisions for heating materials.

Half cylinders of sheet steel set directly upon the ground in the form of an arch, make a simple form of sand heater as also do lengths of metal culvert pipe

closed at one end and provided with a short piece of smaller pipe for a flue. Sand and stone may be heated by piling directly upon the pipe coils supplied with steam or by covering with tarpolins and applying the steam directly to the material to be heated. Where the materials are delivered in cars excellent results can be obtained by this latter method. For heating water the common practice of relying upon a steam pipe placed in an ordinary barrel is not to be recommended, for the water is generally used too fast to permit of its being properly heated by this method. A suitable tank should be provided, the water being heated by means of a coil supplied with steam from the boiler supplying the mixer engine or from one erected for this purpose. The size of the tank will of course depend upon the amount of water needed and the time required for heating it.

Work can be successfully carried on during freezing weather by either one or both of two methods; heating the concrete materials and then protecting the work until it has had a chance to harden, or for temperatures but little below freezing, by lowering the freezing point of the concrete. This latter method is probably the simplest and cheapest but not the best, and consists of adding some substance to the concrete that will reduce its freezing point. Only those substances that have no effect on the strength and durability of the concrete can be used. Ordinary salt is most commonly used for this purpose and experiments indicate that while the addition of a limited amount of salt retards the hardening somewhat and lowers the initial strength, the ultimate strength of the concrete is not affected by its use. Even when salt is used it is important that the aggregate be free from frost as it is impossible to properly mix such materials. Approximately one per cent by weight of salt to the weight of the water is required for each degree F. below freezing, but more than ten per cent should not be considered safe and this amount is not effective for temperatures lower than 22 degrees F. Calcium chloride has been used in place of salt for the same purpose and apparently gives very good results. In one case where commercial muriatic acid was used to prevent freezing, a small amount of acid being added to the mixing water, the results obtained were not entirely satisfactory, and the present unsatisfactory condition of the concrete both as to color and strength, is undoubtedly due to the use of the acid. At any rate the use of acid in this connection is not to be encouraged.

To insure satisfactory results during cold weather the material should be heated and the work protected until it has attained sufficient strength to withstand the action of frost, either the water, sand and water, or sand, stone and water should be heated. Heating the materials accelerates the rate of hardening, lengthens the time before the concrete becomes cold enough to freeze and in temperatures but little below freezing will insure the hardening of the concrete before it can be damaged by freezing.

For heavy mass work, thick walls, abutments, etc., it is not necessary to heat the sand if it is dry and free from lumps of frozen matter. The water, however, should be heated, and if the concrete goes into place unchilled it will harden quite rapidly, as mass work retains its initial heat for a long time and additional heat is generated during the process of hardening. If the forms are tight and made of heavy material it will only be necessary to protect the top or exposed surface of the work. This may be accomplished by covering with tarpaulin and applying a jet of steam, or by covering with boards, building paper or some other suitable material and applying a thick blanket of straw

or manure. A thickness of from 10 to 12 inches laid on paper or canvas will, if kept dry, protect work from freezing for days at a temperature as low as 10 degrees F. Manure should not be placed directly upon the concrete, however, as it is very apt to discolor the work and in some cases it is thought to have caused a slight disintegration of the surface coming in contact with it.

As an additional precaution for keeping the work from freezing through the forms, a covering of building paper furred an inch or two from the forms has been found to be effective. Actual tests in practice have shown a difference in temperature of 15 degrees between the outside air and the space between the paper forms.

The present day practice in handling reinforced concrete building construction during the winter months is practically as follows. Take for example the construction of a building having a reinforced concrete skeleton and floors, and with wooden floors on top of those of concrete. After completing the forms for the first story columns and second story floor slabs, beams and girders, but before depositing any concrete, the entire area is housed in with canvas and heated with salamanders to a temperature of about 60 or 70 degrees F. Where it is possible to obtain sand and broken stone or gravel that is dry and free from frost these materials are usually not heated, but if not they should be heated. All water used for mixing concrete is heated to a temperature of about 100 degrees F. and some engineers and contractors, in addition to using hot water, add about a pint of salt per bag of cement to the mixture. For heating water, provide a tank, about the size of that of an ordinary street sprinkler, equipped with a special heating coil supplied with steam from the boilers used for the mixer and hoist. The concrete when deposited should be quite warm, this initial heat, that supplied from the salamanders on the floor below, and the protection offered by the forms, keeping it from freezing.

The forms for the wall columns of the next story above are placed first and this story housed in with canvas as soon as possible. Enough canvas to house in at least two stories at a time is necessary, salamanders being kept burning on each floor during the time the housing is in place. Work handled in this manner progresses but little slower than similar work concreted under favorable weather conditions, and while it is not possible to remove forms as soon as is customary with summer work, but one additional set of forms is, as a rule, required. Where a cement wearing surface is placed with the floor slab it is necessary to have the housing in place and the salamanders burning on each story before depositing concrete, otherwise it would be impossible to properly finish the surface of the floor.

Careful inspection of winter work is necessary before removing the forms and it must be remembered in this connection that frozen concrete, which, upon thawing, has but little strength, closely resembles thoroughly hardened concrete in appearance, and when broken frequently shows a fracture through the aggregate.

To prohibit placing of concrete when the temperature is near or below freezing, as is frequently done in specifications, causes unnecessary delays and imposes an unjust hardship upon the contractor. If concrete work is properly handled it may be successfully carried on irrespective of weather conditions. The cold weather clause in specifications, instead of prohibiting should be so written as to permit of construc-

tion during freezing weather, provided proper precautions, which should be specified, are taken.

While winter work will entail some additional expense, depending upon the class of construction, there are also advantages to be obtained at this time of the year which compensate for this additional cost. Labor is very apt to be cheaper and more plentiful and the same is true to some extent of the materials of construction, deliveries of which are more prompt. This is a consideration of much importance, as those will affirm who have had work held up for weeks and the cost increased due to the delays in obtaining materials during the busy building season.

Where conditions and importance of the work will warrant this slight extra expense, concrete construction may be carried on during the severest winter weather with the assurance that it will be entirely satisfactory, providing proper precautions are taken in placing and protecting the work.

CEMENT STUCCO EXTERIORS.

Until a comparatively short time ago the word concrete conveyed to the mind an idea of bulky construction, such as immense foundations that were only built for great strength and which were usually hidden from view for all time. In recent years this idea has been greatly modified, and while concrete continues to serve as an indispensable material for foundations, it has also found a use as a material with almost unlimited possibilities in a highly artistic sense. From the idea of mass and bulk to the thought of the almost spider-web structure of concrete framework is a long step, and then to the idea of cast-stone molded into the finest decorative designs is a still greater advance.

The first use of concrete architecturally came with the block construction, the whole tendency being originally the imitation of stone. The present tendency is to treat concrete as concrete, and by surface finish and by decorative contrast to bring out the latent possibilities of the material. Great success has been attained in this field, and as architects become more familiar with the best methods of concrete construction, still greater success will attend their efforts.

The fireproof quality of concrete for building material has been dwelt upon so often and the ground covered so thoroughly that we will only mention it in passing, and will concern ourselves chiefly with the question of the artistic use of cement plaster.

As stated previously, the present development is along the lines of surface treatment and color contrast. The method of removing the forms early, while the concrete is still fresh, and scrubbing the surface with a wire brush has been very successfully used. This exposes the aggregates, and when the stone has been carefully chosen, the effect is most artistic. The use of half-timber with concrete is also very effective, and this method is being extensively developed to-day.

One of the most popular forms of suburban house built within the past twenty years is what is called a "stucco house." Most people do not realize that "stucco" is a term applied to an exterior finish only, and few are aware of the fact that its most important ingredient is cement. Three reasons may be given for its extensive use in suburban residential work. First, its cheapness; second, that it is applicable as an exterior finish to every kind of a house, no matter what material is used in the construction of the walls; third,

any kind of any architectural effect desired can be produced by the use of this material.

Unfortunately this form of finish has been criticised from the standpoint of lasting quality; owing, however, to failures directly traceable to poor workmanship. But stucco, when properly made and applied, will endure for an indefinite length of time.



Fig. 1.—Round-House of Baltimore and Ohio R. R. at Philadelphia. Structural Iron Frame Work with Walls of Stucco.

Stucco is a composite coat, about one and one-half inches thick, placed on the outside of a building. It is, therefore, not that material upon which the house depends for stability. Most houses are built of wood, brick, stone, or concrete, and stucco has been placed successfully upon all of these materials.

Nor is its use confined to house building. There are sometimes occasions where it is the only practical method of securing satisfactory results. Fig. 1 is an example. The walls of this round-house are entirely composed of this material. The old house of wood was destroyed, and it was considered advisable to put in a more lasting structure. The foundations, however, were too light to carry a house of heavier material than wood. A frame of structural iron was erected, and the walls made of stucco. This work has been standing for six years, with perfectly satisfactory results.

Fig. 3 shows a chimney on one of the highest buildings in Philadelphia, surrounded by a stucco casing. The cut shows the excellent condition of the chimney after several years of use. The conditions to which this piece of stucco-work is subjected are particularly severe. The exterior is, of course, exposed to the varying climatic changes, and on account of its exposed position these are extreme, while the range of temperature on the inside of the stucco is even greater, and the exterior may be very cold while at the same time the interior may be very hot.

It is our purpose in this article to give a standard method of placing stucco successfully on each of the four common building materials, wood, brick, stone, and concrete, with illustrations of successful work that have been standing for a number of years. No doubt there are other mixes and methods of application as successful as that given here; but if one follows the specifications and methods of work here laid down carefully, success will be assured. One precaution especially must be observed. The plaster must not be allowed to dry out too rapidly; if it is exposed to the sun, it must be covered with a wet canvas, or the surface frequently sprinkled. It is well to sprinkle the plaster-work in any case. Stucco should never be applied when the temperature is below freezing.

Cement plaster can be used for two purposes—either as a veneer or to form an exterior wall. Quite often it becomes necessary to repair the exterior of a building on account of deterioration. The pointing may

have dropped out, the stonework may have disintegrated, the brick front may have become unsightly, or an old building may need renovating, a more artistic exterior being desired. In such cases the use of cement plaster gives the most satisfactory results. In many instances the finish of a monolithic concrete construction as it comes from the forms is marked by the grain of the boards, and a more pleasing surface is desired. Here also a cement plaster coat can be used. The use of cement plaster for the exterior of frame houses is growing in favor with amazing rapidity. A very artistic and durable finish may be secured. Each of these cases, however, needs a slightly different treatment.

Application of Stucco to Stone.

When it is desired to cover a stone exterior with cement plaster, the surface must be thoroughly cleaned of all loose mortar and disintegrated stone, and before the plaster is applied the surface must be thoroughly wet. The amount of wetting necessary depends upon the character of the stone of which the house is built. If it be a soft, porous stone, a great deal of water must be applied, if it be a hard, compact stone, not so much. In every case the old surface must be sufficiently saturated so that no water will be absorbed from the plaster. This is an important point, and one which is often overlooked, and many failures can be traced to the fact that the surface was not thoroughly saturated with water.

There are several methods of wetting the exterior to be plastered. A large brush can be used, and in a manner similar to that employed in whitewashing a wall. In this way the whole surface can be wet, or



Fig. 2.—Interior of Baltimore and Ohio R. R. Round-House.



Fig. 3.—Chimney of Cement Stucco.

the water can be applied with a hose. When a hose is used, the best way is to spray the water. This can be easily accomplished by compressing the end of the hose. Care must be taken to apply the plaster at once, and before the wall has an opportunity to dry.

If the plaster is applied to a dry, porous surface, the latter will take up so much water that the cement in the plaster will not set. This causes the plaster to dry out, crack, and fall off, and is usually the cause of most of the unsatisfactory results in the use of cement plaster.

The illustrations (Fig. 4 and 5) are excellent examples of old stone exteriors covered with cement plaster. After having removed all loose material and thoroughly saturated the surface of the stone the cement plaster is applied.

The best results are obtained with a mixture of lime-mortar and cement. Lime-mortar alone is not durable, while cement alone is liable to show hair-line cracks, and on account of quick setting is not so readily worked; but a mixture of the two produces a permanent finish and is easily applied. The character of the stone-work governs to some extent the proportion of

cement and lime-mortar to be used. Slake good double-strength lime in plenty of water and stir only enough to prevent the large lumps from burning. After being allowed to stand for a week or ten days, it is ready for use. The cement is then added.

The lime is usually slaked in a box raised slightly from the ground, one end being a little lower than the other, so that the slaked lime will run off. The lower end should have a sliding door, with the opening covered with a coarse wire screen which acts as a strainer, thus preventing any unslaked lumps from leaving the box. After the lime has completely slaked, it is run off into a crater of sand and the lime and sand are thoroughly mixed.

The cement is added just before the plaster is applied, and only a small quantity should be prepared at a time. The cement sets rapidly, and if this occurs before application it will lose its value. If a large quantity of the cement-lime mixture were prepared, the cement would set before it could be used. This is an important point to be observed, and if neglected, causes failure. The cement is first thoroughly mixed with sand, and then this dry mixture of cement and sand is worked into the lime paste. The proportions by volumes should be one part lime-mortar to six parts of cement and sand mortar, the latter mixed about 1 to 1. While the first coat is wet it is scratched deeply over the entire surface and as soon as it has sufficiently set to support the second coat, the second coat is applied.

If a thick plaster coat is desired, a third coat is applied when the second coat is dry, but usually the finish is obtained from the second coat. The finish may be either smooth, rough-cast, pebble-dash, or slap-dash. A rough-cast finish can be obtained by using trowels covered with carpet or burlap. It is not well to trowel the surface too much, as the plaster is liable to crack and fall off if the cement is disturbed after it has started to set.



Fig. 4.—Cement Stucco on Stone.



Fig. 5.—Cement Stucco on Stone.

Methods of Finishing.

Rough-cast.—To obtain the best results a slight excess of sand is used and the plaster should not be very wet. The sand should be large-grained and coarse, as this adds to the rough appearance of the surface. A beautiful white finish can be secured by using white sand and white cement, or by using the white sand with ordinary Portland cement. Lime paste also whitens the plaster.

Slap-dash.—A slap-dash finish can be secured by throwing on the second coat with a wooden paddle, but it takes an expert to do good work in this manner.

Pebble-dash.—A pebble-dash surface can be secured by applying the second coat fairly wet and then throwing clean pebbles into the fresh plaster. The pebbles should be about $\frac{1}{2}$ inch in diameter and should run uniformly. Before throwing them on the fresh plaster the pebbles should be wet. The work should be started at the top and the pebbles thrown with a sweeping motion such as is used in sowing grain. The pebbles must, of course, be distributed uniformly over the sur-



Fig. 6.—Pebble Dash Finish.

face, and must be thrown against the fresh soft plaster with sufficient force to embed them securely.

Care must be taken not to disturb the cement after it has started to set, and in order to avoid this, the surface must be covered with the pebbles immediately after the fresh plaster is applied. A plasterer by ordinary quick work can cover a surface 6 feet square with plaster and then apply the pebbles.

Particular care must be taken to make the whole surface continuous; that is, one patch of plaster must not be allowed to dry before the adjoining space is covered. If this precaution is not observed, cracks are likely to occur in the finished surface.

A similar finish can be obtained by mixing the cement and lime paste to the consistency of thick cream and then adding the washed pebbles in the proportion of 5 parts plaster to 1 part pebbles by volume. This mixture is applied either with a trowel or by dashing it on with a wooden paddle about 6 inches wide. The finish is often tinted yellow, and for this purpose French yellow ochre is best. Enough coloring matter is added to the mixture to give the desired tint before



Fig. 7.—Cement Stucco On Old Brick Work.

applying. A yellow tint can also be secured by using brown sand or gravel.

Application of Stucco to Stone.

The treatment of a brick surface is very similar to that of a stone exterior. The porous nature of the brick, however, necessitates the utmost care in wetting before the first coat is applied, or the results will not be satisfactory. If the brick wall has been painted and this paint is scaling off, as it often does, it should be thoroughly scraped and cleaned, and all loose mortar removed. If possible, the old mortar should be picked out $\frac{1}{2}$ to $\frac{3}{4}$ of an inch from the face of the brickwork, and when the first coat is applied it is forced into these crevices and forms an excellent bond. The comparatively smooth surface of the brick wall will require less material for the first coat than a rough surface of stone. The first coat over the brickwork must be scratched thoroughly and allowed to set until it is strong enough to support the second coat. The second coat is then applied in the same way as has been described.

The original smooth surface of the brick wall lends itself very readily to a smooth plaster finish. This is



Fig. 8.—Philadelphia Opera House. Cement Plaster Finish on Brick.

obtained by using a finish coat containing rather fine sand and placed with a steel trowel. When it is desired to obtain an Old English style of exterior, the smooth finish coat is necessary. Very artistic and desirable results have been secured by thus renovating brick exteriors, as the accompanying illustrations show.

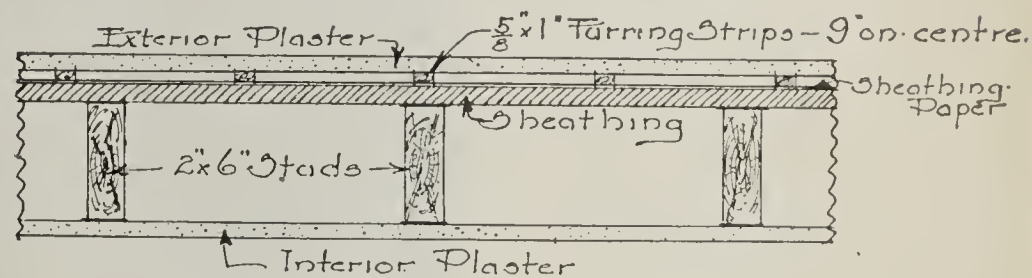
An excellent example of the adaptability of a cement plaster finish is shown in the photograph of the Philadelphia Opera House (Fig. 8.) All the pilasters and semicircular arches over the windows, as well as the marquis, are covered with cement plaster. This plaster was composed of one part white Portland cement to two parts marble-dust. No lime was used. The joints between the bricks were picked back about $\frac{3}{4}$ of an inch when they were laid, and the first coat was forced well into the crevices. The second coat was used for finishing. The question of time was an essential feature in the erection of this building, and had stone been used a considerable delay would have oc-

curred—first in securing the stone, and later in setting it into place. The construction used not only saved time and expense, but enabled the builder to secure a most artistic appearance.

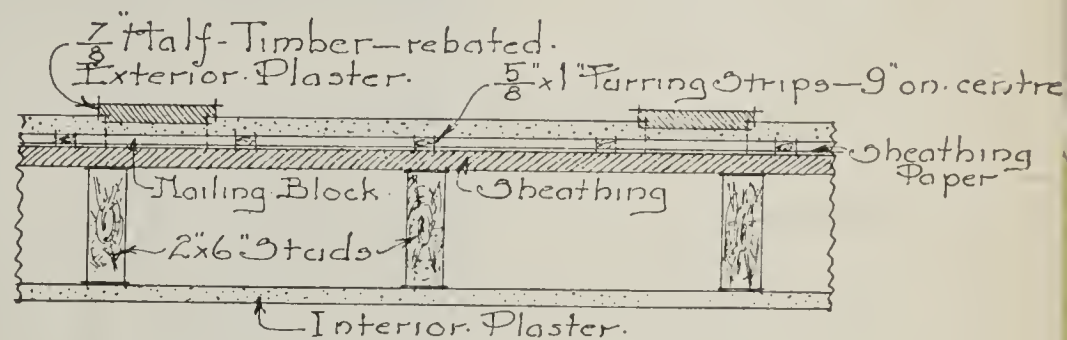
Another instance of the use of cement plaster applied to brick to save time and expense was that of the History Building, at the Jamestown Exposition. A mixture of 2 parts sand and 1 of cement was applied directly to the brick after the joints had been picked out. This building was started shortly before the exposition opened, and had to be completed in the shortest possible time. On account of the valuable collection of relics and paintings it was to contain, an absolutely waterproof wall was essential. The cement plaster coat served both purposes, and by allowing the red brick to show in the pilasters a pleasing contrast was secured.

Application of Stucco to Concrete.

The treatment of a concrete surface that needs to be plastered depends upon whether the wall is new or old. The best results are obtained by placing the plaster immediately after the forms have been removed



PLAIN PLASTERED WALL.



HALF-TIMBERED WALL.

and while the concrete is still green. In this case very little or no preparation of the concrete is necessary to receive the plaster, which is applied before the wall has dried out. A single coat is usually all that is required, and the finish desired may be secured in the same manner as with the final coat over a stone or brick exterior. If the concrete wall is old, much care must be taken in preparing it for the plaster. The excess of cement likely to have flushed to the surface must be removed and the surface thoroughly cleaned and well wet before applying the plaster, or it will crack and fall off. In the January issue of the *Concrete Review* the treatment of concrete surfaces by exposing the aggregates was described, and this will perhaps be found to be a cheaper and better method of securing a more pleasing surface than by plastering. In that issue a method of placing a plaster finish and building the concrete wall at the same time was described.

Stucco on Lath.

Instead of applying the plaster finish directly to the surface to be treated, the method of using a lath to support the plaster has been successfully employed. Wood or metal lath can be used, preferably the latter. Furring should be secured to the old surface and the



Fig. 10.—Building at Jamestown Exhibition.

lath fastened to this. In the case of stone or brick walls, the furring can be attached by means of staples driven into wooden plugs in the joints of the old wall. Either narrow wooden strips or metal furring made especially for this purpose may be used. Metal furring is flat wire or band iron crimped for stiffness. It is set on edge so that the width to use depends upon the thickness of mortar wanted between the lath and surface to which the lath is applied. It is made in widths of 1/4 inch to 1 inch, and the quantities required are given in the following table:

bring out the door and window trim unless the plaster is to finish flush with the old trim, or if it is desired to keep the old frames and have them project, it will be necessary to remove the old siding and staple the furring directly to the old studding. Frequently the trim is removed and the lath brought around the casing, thus getting a recessed window with no wood showing.

The cuts shown (Figs. 15 and 16) illustrate the possibilities of cement plaster work. An old brick building of unsightly appearance occupied this site, and a



Fig. 14.—Old Frame House Covered With Cement Plaster.

Quantities per 100 square yards of lath.

Width of Furring	Material	Lineal Ft. per lb.	Pounds Required	
			12 in. ctrs.	16 in. ctrs.
1/4 inch.....	Flat wire.	20	50	37
1/2 ".....	Band iron.	20	40	34
3/4 ".....	" "	15	67	45
1 ".....	" "	10	90	67

still older and more dilapidated one adjoined it. The present attractive buildings were made possible by applying to the exteriors a coating of cement plaster. The fronts were covered with ordinary chicken-wire furred out about 3/4 inch and the cement plaster was forced through the meshes. The finish was obtained from the second coat. In the building used for a store and offices tiles of various bright colors were em-



Fig. 15.—Concrete Stucco Building.

Old frame buildings can be readily renovated by using cement stucco. The exterior is covered with lath furred out as described and either two or three coats are applied. In such a case it is necessary to

bedded in the final coat while it was fresh and a very artistic result was obtained. The photograph fails to bring out the pleasing appearance of this finish.

When this method is used, or when the metal lath is

employed, the cement and sand mortar should be used without any admixture of lime-mortar. A mixture of one part cement to two parts of sand gives the best results. The mortar should contain hair in sufficient quantity to form a good key.

does not require painting, and it is exceedingly durable. Either metal lath or wood lath can be used, but the metal is preferable. The wood lath, if used, should be wet enough to prevent it absorbing any moisture from the plaster, but not wet enough to cause it to



Fig. 16.—Cement Stucco Finish on Wire.

Area Covered by Mortar.

Produced from One Barrel of Portland Cement Mortar (3.8 cu. ft. Cement-Paste). No lime.

Composition of Mortar.	Coat. Thickness of	Area Covered. Square Feet of
1 Cement, 1 Sand.....	1 inch	67
	$\frac{3}{4}$ "	90
	$\frac{1}{2}$ "	134
1 Cement, 2 Sand.....	1 inch	104
	$\frac{3}{4}$ "	139
	$\frac{1}{2}$ "	208
1 Cement, 3 Sand.....	1 inch	140
	$\frac{3}{4}$ "	187
	$\frac{1}{2}$ "	280

Cement Stucco on Frame Houses.

We have referred previously to the great popularity of the cement stucco work on frame houses. This finish possesses many advantages over the ordinary wood exterior—it presents a handsome appearance, it

swell, because it will shrink again upon drying, and cause the plaster to crack. Green wood lath is better than dry.

Before describing a method of applying stucco to wooden lath we would advise that this never be attempted in important work. In the case of small buildings, or such as may need patching, it offers a cheap method of obtaining a pleasing exterior, but is very apt to prove a failure. The reason is as follows: If the lath is too dry when the stucco is applied, it will absorb moisture from the plaster to the degree that the cement will not set properly and in time the stucco will fall off. On the other hand, wood made too wet will contract when it becomes dry and the same disastrous results are apt to follow. For the reasons given it is best to use a metal lath where the importance of the undertaking will warrant it.

Specifications for Lath.

Metal lath is generally specified by gauge and it is always designated by gauge in catalogues.

The gauge number is that of the United States standard gauge of the sheets used, before the lath is cut. The cutting and expanding processes so alter the material that it is practically impossible to discover the gauge with micrometers, so that it is easily possible for an unscrupulous dealer to pass off a lighter gauge.

To guard against this, all purchasers of lath should specify the gauge and weight. The weight per square yard of the lath in different gauges is given in the table below. The weights there given are usually guaranteed with a 2½ per cent. allowable variation, the variation with the sheets of steel are purchased from the mills.

Size of Sheet 18×96 In.	Weight per Bundle	Yards per Bundle	Sheets per Bundle	Weight per Yard	Yards in 100 Pounds
No. 27 Gauge....	27½ lbs.	12	9	2½ lbs.	43
No. 26 "	30 "	12	9	2½ "	40
No. 25 "	35 "	12	9	2.9 "	34½
No. 24 "	40½ "	12	9	3.4 "	29½

Painting adds but little weight to the lath.
Galvanizing adds from 0.75 lb. to 0.9 lb. per square yard according to the gauge of the lath.

Beware of lath cut from sheets galvanized before cutting and expanding, for only two sides of the four in each strand have any galvanizing on them, and these are badly cracked and scaled during the process of expanding

Be sure and specify the gauge of the metal from which the lath is cut, and in addition thereto the weight per square yard, and if coated or galvanized add the weight of the protection.

Fasten the sheets horizontally, i. e., the long way of the mesh being horizontal, so that the length of the sheets is across the studding instead of being placed vertically.

The dip of the strand should be inward and downward, away from the workmen, so that a perfect key can be formed.

Grounds should allow ⅜ inch over face of lath. Edges of sheets should lap about the width of one mesh and no more, simply to make the lath stiff, and the meshes should nest.

When using metal studding, the lath will be fastened in the manner provided, which differs with the studs made by different makers.

When the lath is placed on wooden studding, it is advisable to use crimped metal furring to provide a key between the lath and the studding, to maintain a uniform thickness of plaster, and also to prevent the line of studding from showing through the plaster, owing to the difference in the moisture in the plaster against the studding and that between adjacent studs.

For walls place studs 12 to 16 inches on centers. Twelve inches is best for ceiling beams, channels, or T's.

Staples should be about 5 inches apart and of sufficient length to go through lath and astride of furring strip into the wood at least one inch. When fastened to metal channels or T's, galvanized wire is used.

When plastering on walls of brick, concrete, etc., metal furring should be always used.

In building a cement stucco-finished house the usual construction is completed as far as the exterior sheathing. Precaution must be taken to make the framework as stiff as possible. Often all the exterior sheathing is placed diagonally so that no swaying will occur to crack the plaster, although metal lath reinforces the cement work considerably and prevents to a great extent any surface cracking. The following is a good

example of specification for stucco work, and the illustration (Fig. 17) shows a very successful use of this method of finishing a building.

“Exterior Lathing and Plastering.

“Lathing.—Cover all exterior walls, etc., shown for plaster with an approved galvanized woven wire lath secured to ⅝-inch by 1-inch furring strips set 9 inches O. C. with 1-inch galvanized staples every 5 inches. All lath must run at right angles to furring, and all joints are to be made where they will be covered with half timber, and joints are to be broken every course.

“Plaster.—All walls, etc., shown on elevation for plaster to be three-coat work on wire lath as follows: The first coat is to be composed of 2 parts rich lime-mortar and 1 part Portland cement, with a large proportion of long cow-hair. The lime-mortar is to be mixed four days before using, and the cement is not to be added until the mortar is ready to be used, and is to be mixed in small quantities as the work progresses. The face of the first coat must be well scratched to make a key for the second coat, and shall be thoroughly dry and surface cracks appear before the second coat is applied. The second coat will be the same composition as the first, except that the cow-hair is omitted. The scratch coat will be dampened before the second coat is applied. The third coat will be the same as the second, except that a coarse sand will be used and the third coat will be floated up to a rough finish. All sand used in the exterior work is to be approved by the architect. The contractor will be careful to bring his plaster work up perfectly flush with nailing grounds furnished and set by carpenter. No exterior plaster will be attempted until the building is under roof and all interior partitions are studded up and braced.”

Specifications are by Folsome, Crowell, and Stanton, Philadelphia. The durability of stucco work from these specifications would be greatly increased by a larger proportion of cement. The varieties of finish possible are numerous. A rough or smooth surface, a pebble-dash, rough-cast or slap-dash finish, as noted previously, are readily secured in using cement plaster over lath.

The final coat is frequently colored. The following table for use of coloring materials is from the 1904 Annual Report of the Ohio State Geologist. The slight differences in recipes are due to the fact that three authorities are given.

Materials used in Coloring Mortars.

Produced from One Barrel of Portland Cement Mortar (3.8 cu. ft. Cement-Paste). No lime.

Color.	Mineral.	Pounds of Color to 100 lbs. of Cement.		Lbs. Color to bbl. of Cement.
		1	2	
Gray	Germantown Lamp Black	1-4	1-2	2
Black	Manganese Dioxide	12	00	48
Black	Excelsior Carbon Black	00	2	00
Blue	Ultramarine	5	5 to 6	20
Green	Ultramarine Green	6	6	24
Red	Iron Oxide	6	6 to 10	24
Bright Red	Pompeian or English Red	6	6	24
Sandstone	Red-Purple Oxide of Iron	6	00	24
Violet	Violet Oxide of Iron	6	00	24
Brown	Roasted Iron Oxide or Brown Ochre	6	6	24
Yellow or Buff	Yellow Ochre	6	6 to 10	24

The method of half timbering over stucco finish has been largely used, and excellent artistic affects are possible. The stucco-finished house is more nearly fire-proof than the ordinary frame house, and this is an advantage that cannot be overestimated.

PROGRESS REPORT OF THE JOINT COMMITTEE ON CONCRETE AND RE-INFORCED CONCRETE OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.

II. Adaptability of Concrete and Reinforced Concrete.

The adaptability of concrete and reinforced concrete for engineering structures, or parts thereof, is now so well established that it may be considered one of the recognized materials of construction. It has proved to be a satisfactory material, when properly used, for those purposes of which its qualities make it particularly suitable.

1. Proper Use.

Concrete is a material of very low tensile strength and capable of sustaining but very small tensile deformations without rupture; its value as a structural material depends chiefly upon its durability, its fire-resisting qualities, its strength in compression and its relatively low cost. Its strength increases generally with age.

Plain concrete or massive concrete is well adapted for structural forms in which the principal stresses are compressive. These include foundations, dams, retaining walls and other walls, piers, abutments, short columns and, in many cases, arches. In the design of massive concrete, the tensile strength of the material must generally be neglected.

By the use of metal reinforcement to resist the principal tensile stresses, concrete becomes available for general use in a great variety of structures and structural forms. This combination of concrete and metal is particularly advantageous in the beam, where both compression and tension exist; it is also advantageous in the column, where the main stresses are compressive, but where cross-bending may exist. In structures resisting lateral forces it possesses advantages over plain concrete in that it may be so designed as to utilize more fully the strength rather than the weight of the material.

2. Improper Use.

Failures of reinforced concrete structures are usually due to any one of a combination of the following causes: defective design, poor material, and faulty execution.

The defects in a design may be many and various. The computations and assumptions on which they were based may be faulty and contrary to the established principles of statics and mechanics; the unit stresses used may be excessive, or the details of the design defective.

The design of reinforced concrete structures should receive at least the same careful consideration as those of steel, and only engineers with sufficient experience and good judgment should be intrusted with such work.

The computations should include all minor details, which are sometimes of the utmost importance. The design should clearly show the size and position of the reinforcement and should provide for proper con-

nection between the component parts, so that they cannot be displaced. As the connections between reinforced concrete members are frequently a source of weakness, the design should include a detailed study of such connections, accompanied by computations to prove their strength.

The use of high unit stresses, approaching the danger line, is a defect in the design of reinforced concrete structures.

Articulated concrete structures designed in imitation of steel trusses, may be mentioned as illustrating a questionable use of reinforced concrete.

Poor material is sometimes used for concrete, as well as for reinforcement. The use of inferior concrete is generally due to a lack of experience of the contractor and his superintendents, or to the absence of proper supervision.

A unsuitable quality of steel for reinforcement is sometimes prescribed in specifications, for the purpose of reducing the cost. For steel structures, a high grade of material is specified, while the steel used for reinforcing concrete is sometimes made of unsuitable, brittle material.

Faulty execution and careless workmanship may generally be attributed to unintelligent or insufficient supervision.

While other engineering structures upon the safety of which human lives depend are generally designed by engineers employed by the owner, and the contracts let on the engineer's design and specifications, in accordance with legitimate practice, reinforced concrete structures are frequently designed by contractors or by engineers commercially interested, and the contract let for a lump sum.

The construction of buildings in large cities is regulated by ordinances or building laws, and the work is inspected by municipal authorities. For reinforced concrete work, however, the limited supervision which municipal inspectors are able to give is not sufficient. Means for more adequate supervision and inspection should, therefore, be provided.

3. Responsibility and Supervision.

The execution of the work should not be separated from the design, since intelligent supervision and successful execution can be expected only when both functions are combined. The engineer who prepares the design and specifications should therefore have the supervision of the execution of the work.

The committee recommends the following rules for structures of reinforced concrete for the purpose of fixing the responsibility and providing for adequate supervision during construction:

(a) Before work is commenced, complete plans shall be prepared, accompanied by specifications, static computations, and descriptions showing the general arrangement and all details. The static computations shall give the loads assumed separately, such as dead and live loads, wind and impact, if any, and the resulting stresses.

(b) The specifications shall state the qualities of the materials to be used for making the concrete, and the manner in which they are to be proportioned.

(c) The strength which the concrete is expected to attain after a definite period shall be stated in the specifications.

(d) The drawings and specifications shall be signed by the engineer and the contractor.

(e) The approval of plans and specifications by other authorities shall not relieve the engineer nor the contractor of responsibility.

(f) Inspection during construction shall be made by competent inspectors employed by, and under the

supervision of, the engineer and shall cover the following:

1. The materials.
2. The correct construction and erection of the forms and the supports.
3. The sizes, shapes and arrangement of the reinforcement.
4. The proportioning, mixing and placing of the concrete.
5. The strength of the concrete by tests of standard test pieces made on the work.
6. Whether the concrete is sufficiently hardened before the forms and supports are removed.
7. Prevention of injury to any part of the structure by and after the removal of the forms.
8. Comparison of dimensions of all parts of the finished structure with the plans.

(g) Load tests on portions of the finished structure shall be made where there is reasonable suspicion that the work has not been properly performed, or that, through influences of some kind, the strength has been impaired. Loading shall be carried to such a point that twice the calculated working stresses in critical parts are reached, and such loads shall cause no permanent deformations. Load tests shall not be made until after 60 days of hardening.

4. Destructive Agencies.

(a) **Corrosion of Metal Reinforcement.**—Tests and experience have proved that steel embedded in good concrete will not corrode, no matter whether located above or below fresh or sea water level. If the concrete is porous so as to be readily permeable to water, as where the concrete is laid with a very dry consistency, the metal may be corroded in the presence of moisture.

(b) **Electrolysis.**—There is little accurate information available as to the effect of electrolysis on concrete. The few experiments that are available seem to indicate that concrete may be damaged through the leakage of small electrical currents through the mass, particularly where steel is embedded in the concrete. These experiments are not conclusive, however, and the large number of reinforced concrete structures subject to the action of electrolysis in which the metal and concrete are in perfect condition would seem to indicate that the destructive action reported was due to abnormal conditions which do not often occur in practice.

(c) **Sea Water.**—The data available concerning the effect of sea water on concrete or reinforced concrete are inconclusive and limited in amount. There have been no authentic cases reported where the disintegration has proved to be due entirely to sea water. The decomposition that has been reported manifests itself in a number of ways; in some cases the mortar softens and crumbles; in others, a crust forms which in time comes off. It has been found, however, that where concrete is proportioned in such a way as to secure a maximum density and is mixed thoroughly, it makes an impervious concrete, upon which sea water has apparently little effect. Sea walls have been standing for considerable lengths of time without apparent injury. In many of our harbors where the water has been rendered brackish through the rivers discharging into them, the action that has been reported has been at the water line and was probably due in part to freezing.

(d) **Acids.** Concrete of first-class quality, thor-

oughly hardened, is effected appreciably only by strong acids which seriously injure other materials. A substance like manure, because of the acid in its composition, is injurious to green concrete, but after the concrete has thoroughly hardened it satisfactorily resists such action.

(e) **Oils.** When concrete is properly made and the surface carefully finished and hardened, it resists the action of such oils as petroleum and ordinary engine oils. Certain oils which contain fatty acids appear to produce injurious effects.

(f) **Alkalies.** The action of alkalies on concrete is problematical. In the reclamation of arid land where the soil is heavily charged with alkaline salts, it has been found that concrete, stone, brick, iron and other materials are injured under certain conditions. It would seem that at the level of the ground water such structures are disintegrated, possibly due in part to the effect of formation of crystals resulting from the alternate wetting and drying of the surface of the concrete at this ground water line. Such destructive action can be prevented by the use of an insulating coating which will prevent this action from taking place.

III. Materials.

A knowledge of the properties of the materials entering into concrete and reinforced concrete is the first essential. The importance of the quality of the materials used cannot be over-estimated, and not only the cement but also the aggregates should be subject to such definite requirements and tests as will insure a concrete of the required quality.

1. Cement.

There are available for construction purposes Portland, natural, and Puzzolan or slag cements. Only Portland cement is suitable for reinforced concrete.

(a) **Portland Cement** is the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials. It has a definite chemical composition varying within comparatively narrow limits.

Portland cement should be used in reinforced concrete construction and any construction that will be subject to shocks or vibrations or stresses other than direct compression.

(b) **Natural Cement** is the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas. While the limestone must have a certain composition, this composition may vary in much wider limits than in the case of Portland cement. Natural cement does not develop its strength as quickly nor is it as uniform in composition as Portland cement.

Natural cement may be used in massive masonry where weight rather than strength is the essential feature.

Where economy is the governing factor a comparison may be made between the use of natural cement that will develop the same strength.

(c) **Puzzolan or Slag Cement** is the finely pulverized product resulting from grinding a mechanical mixture of granulated basic blast furnace slag and hydrated lime.

Puzzolan cement is not nearly as strong, uniform or reliable as Portland or natural cement, is not extensively used and never in important work; it should be used only for foundation work underground where it is not exposed to air or running water.

(d) **Specifications.** The cement should meet the

requirements of the Standard Specifications for Cement (see Appendix p. 255). A number of societies have been working on methods for testing and specifications for cement. The best practice seems to be represented in the standard methods of testing and specifications for cement which are the result of the joint labors of special committees of the American Society of Civil Engineers, American Society for Testing Materials, American Railway Engineering and Maintenance of Way Association, American Institute of Architects, and others.

2. Aggregates.

Extreme care should be exercised in selecting the aggregates for mortar and concrete, and careful tests made of the materials for the purpose of determining their qualities and the grading necessary to secure maximum density* or a minimum percentage of voids.

(a) **Fine Aggregate** consists of sand, crushed stone, or gravel screenings, passing when dry a screen having $\frac{1}{4}$ -inch diameter holes. It should be preferably of silicious material, clean, coarse, and free from vegetable loam or other deleterious matter.

A gradation of the grain from fine to coarse is generally advantageous.

Mortars composed of one part Portland cement and three parts fine aggregate by weight when made into briquettes should show a tensile strength of at least 70 per cent of the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand.

(b) **Coarse Aggregate** consists of inert material, such as crushed stone, or gravel, which is retained on a screen having $\frac{1}{4}$ -in. diameter holes. The particles should be clean, hard, durable, and free from all deleterious materials. Aggregates containing soft, flat or elongated particles, should be excluded from important structures. A gradation of sizes of the particles is generally advantageous.

The maximum size of the coarse aggregate shall be such that it will not separate from the mortar in laying and will not prevent the concrete from fully surrounding the reinforcement or filling all parts of the forms. Where concrete is used in mass, the size of the coarse aggregate may be such as to pass a 3-in. ring. For reinforced members a size to pass a 1-in. ring, or a smaller size may be used.

Cinder concrete is not suitable for reinforced concrete structures, and may be safely used only in mass for very light loads or for fireproofing.

Where cinder concrete is permissible the cinders used as the coarse aggregate should be composed of hard, clean, vitreous clinker, free from sulphides, unburned coal or ashes.

3. Water.

The water used in mixing concrete should be free from oil, acid, strong alkalies, or vegetable matter.

4. Metal Reinforcement.

The Committee recommends as a suitable material for reinforcement, steel filling the requirements of the specifications adopted by the American Railway Engineering and Maintenance of Way Association (Appendix p. 255).

For the reinforcement of slabs, small beams, or minor details, or for the prevention of shrinkage cracks where wire or small rods are suitable, material conforming to the requirements of either specification A or B given in the Appendix (p. 257) may be used.

* A convenient coefficient of density is the ratio of the sum of the volumes of materials contained in a unit volume to the total unit volume.

The reinforcement should be free from rust, scale, or coatings of any character which would tend to reduce or destroy the bond.

IV. Preparation and Placing of Mortar and Concrete.

1. Proportions.

The materials to be used in concrete should be carefully selected, of uniform quality, and proportioned with a view to securing as nearly as possible a maximum density.

(a) **Unit of Measure.**—The unit of measure should be the barrel, which should be taken as containing 3.8 cu. ft. Four bags containing 94 lbs. of cement each should be considered the equivalent of one barrel. Fine and coarse aggregate should be measured separately as loosely thrown into the measuring receptacle.

(b) **Relation of Fine and Coarse Aggregate.**—The fine and coarse aggregate should be used in such relative proportions as will insure maximum density. In unimportant work it is sufficient to do this by individual judgment, using correspondingly higher proportions of cement; for important work these proportions should be carefully determined by density experiments and the sizing of the fine and coarse aggregates should be uniformly maintained or the proportions changed to meet the varying sizes.

(c) **Relation of Cement and Aggregates.**—For reinforced concrete construction a density proportion based on 1:6 should generally be used; i. e., one part of cement to a total of six parts of fine and coarse aggregates measured separately.

In columns richer mixtures are often required, while for massive masonry or rubble concrete a leaner mixture of 1:9 or even 1:12 may be used. These proportions should be determined by the strength or wearing qualities required in the construction at the critical period of its use. Experienced judgment based on individual observation and tests of similar conditions in similar localities is the best guide as to the proper proportions for any particular case.

2. Mixing.

The ingredients of concrete should be thoroughly mixed to the desired consistency, and the mixing should continue until the cement is uniformly distributed and the mass is uniform in color and homogeneous, since maximum density and therefore greatest strength of a given mixture depends largely on thorough and complete mixing.

(a) **Measuring Ingredients.**—Methods of measurements of the proportions of the various ingredients, including the water, should be used, which will secure uniform measurements at all times.

(b) **Machine Mixing.**—When the conditions will permit, a machine mixer of a type which insures the uniform proportioning of the materials throughout the mass should be used, since a more thorough and uniform consistency can be thus obtained.

(c) **Hand Mixing.**—When it is necessary to mix by hand, the mixing should be on a water-tight platform and especial precautions should be taken to turn the materials until they are homogeneous in appearance and color.

(d) **Consistency.**—The materials should be mixed wet enough to produce a concrete of such a consistency as will flow into the forms and about the metal reinforcement, and which, at the same time, can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar.

(e) **Retempering.**—Retempering mortar or concrete, i. e., remixing with water after it has partially set, should not be permitted.

3. Placing of Concrete.

(a) **Methods.**—Concrete after the addition of water to the mix should be handled rapidly, and in as small masses as is practicable, from the place of mixing to the place of final deposit, and under no circumstances should concrete be used that has partially set before final placing. A slow setting cement should be used when a long time is likely to occur between mixing and final placing.

The concrete should be deposited in such a manner as will permit the most thorough compacting, such as can be obtained by working with a straight shovel or slicing tool kept moving up and down until all the ingredients have settled in their proper place by gravity and the surplus water has been forced to the surface.

In depositing the concrete under water, special care should be exercised to prevent the cement from being floated away, and to prevent the formation of laitance which hardens very slowly and forms a poor surface on which to deposit fresh concrete. Laitance is formed in both still and running water, and should be removed before placing fresh concrete.

Before placing the concrete care should be taken to see that the forms are substantial and thoroughly wetted and the space to be occupied by the concrete free from debris. When the placing of the concrete is suspended, all necessary grooves for joining future work should be made before the concrete has had time to set.

When the work is resumed, concrete previously placed should be roughened, thoroughly cleansed from foreign material and laitance, drenched and slushed with a mortar consisting of one part Portland cement and not more than two parts fine aggregate.

The faces of concrete exposed to premature drying should be kept wet for a period of at least 7 days.

(b) **Freezing Weather.**—Concrete for reinforced structures should not be mixed or deposited at a freezing temperature, unless special precautions are taken to avoid the use of materials containing frost or covered with ice crystals, and to provide means to prevent the concrete from freezing after being placed in position and until it has thoroughly hardened.

(c) **Rubble Concrete.**—Where the concrete is to be deposited in massive work, its value may be improved and its cost materially reduced through the use of clean stones thoroughly embedded in the concrete as near together as is possible and still entirely surrounded by concrete.

V. Forms.

Forms should be substantial and unyielding, so that the concrete shall conform to the designed dimensions and contours, and should be tight to prevent the leakage of mortar.

The time for removal of forms is one of the most important steps in the erection of a structure of concrete or reinforced concrete. Care should be taken to inspect the concrete and ascertain its hardness before removing the forms.

So many conditions affect the hardening of concrete, that the proper time for the removal of the forms should be decided by some competent and responsible person, especially where the atmospheric conditions are unfavorable.

VI. Details of Construction.

1. Joints.

(a) **Reinforcement.**—Wherever in tension reinforcement it is necessary to splice the reinforcing bars, the length of lap shall be determined on the basis of the safe bond stress and the stress in the bar at the

point of splice; or a connection shall be made between the bars of sufficient strength to carry the stress. Splices at points of maximum stress should be avoided. In columns, large bars should be properly butted and spliced; small bars may be treated as indicated for tension reinforcement or their stress may be taken off by being embedded in large masses of concrete. At foundations, bearing plates should be provided for large bars or structural forms.

(b) **Concrete.**—For concrete construction it is desirable to cast the entire structure at one operation, but as this is not always possible, especially in large structures, it is necessary to stop the work at some convenient point. This point should be selected so that the resulting joint may have the least possible effect on the strength of the structure. It is therefore recommended that the joint in columns be made flush with the lower side of the girders; that the joints in girders be at a point midway between the supports, but should a beam intersect a girder at this point, the joint should be offset a distance equal to twice the width of the beam; that the joints in the members of a floor system should in general be made at or near the center of the span.

Joints in columns should be perpendicular to the axis of the column, and in girders, beams and floor slabs, perpendicular to the plane of their surfaces.

2. Shrinkage.

Girders should never be constructed over freshly formed columns without permitting a period of at least two hours to elapse, thus providing for settlement or shrinkage in the columns. Before resuming work the top of the column should be thoroughly cleansed of foreign matter and laitance. If the concrete in the column has become hard, the top should also be drenched and slushed with a mortar consisting of one part Portland cement and not more than two parts fine aggregate before placing additional concrete.

3. Temperature.

Concrete is sensitive to temperature changes and it is necessary to take this fact into account in designing and erecting concrete structures. In some positions the concrete is subjected to a much greater fluctuation in temperature than in others, and in such cases joints are necessary. The frequency of these joints will depend, first, upon the range of temperature, to which concrete will be subjected; second, upon the quantity and position of the reinforcement. These points should be determined and provided for in the design. In massive work, such as retaining walls, abutments, etc., built without reinforcement, joints should be provided, approximately every 50 feet throughout the length of the structure. To provide against the structures being thrown out of line by unequal settlement, each section of the wall may be tongued and grooved into the adjoining section. To provide against unsightly cracks, due to unequal settlement, a joint should be made at all sharp angles.

4. Fireproofing.

The actual fire tests of concrete and reinforced concrete have been limited, but experience, together with the results of tests so far made, indicate that concrete may be safely used for fireproofing purposes. Concrete itself is incombustible and reasonably proof against fire when composed of a silicious sand and a hard, coarse aggregate such as igneous rock.

For a fireproof covering these same materials may be used, or clean, hard burned cinders may be substituted for the coarse aggregate.

The low rate of heat conductivity of concrete is one

reason for its value for fireproofing. The de-hydration of the water of crystallization of concrete probably begins at about 500° F. and is completed at about 900° F., but experience indicates that the volatilization of the water absorbs heat from the surrounding mass, which, together with the resistance of the air cells, tends to increase the heat resistance of the concrete, so that the process of dehydration is very much retarded. The concrete that is actually affected by fire remains in position and affords protection to the concrete beneath it.

It is recommended that in monolithic concrete columns, the concrete to a depth of 1½ ins. be considered as protective covering and not included in the effective section.

The thickness of the protective coating required depends upon the probable duration of a fire which is likely to occur in the structure and should be based on the rate of heat conductivity. The question of the conductivity of concrete is one which requires further study and investigation before a definite rate for different classes of concrete can be fully established. However, for ordinary conditions it is recommended that the metal in girders and columns be protected by a minimum of 2 ins. of concrete; that the metal in

of these compounds are of but temporary value, and in time lose their power of imparting impermeability to the concrete.

In the case of subways, long retaining walls, and reservoirs, leakage cracks may be prevented by horizontal and vertical reinforcement, properly proportioned and located provided the concrete itself is impervious. Such reinforcement distributes the stretch due to contraction or settlement so that the cracks are too minute to permit leakage, or are soon closed by infiltration of silt.

Asphaltic or coal tar preparations applied either as a mastic or as a coating on felt or cloth fabric, are used for waterproofing, and should be proof against injury by liquids or gases.

6. Surface Finish.

Concrete is a material of an individual type and should not be used in imitation of other structural materials. One of the important problems connected with the use of concrete is the character of the finish of exposed surfaces. The finish of the surface should be determined before the concrete is placed, and the work conducted so as to make possible the finish desired. For many forms of construction the natural surface of the concrete is unobjectionable, but fre-



Concrete Flower Vases and Lighting Pillars, Humboldt Park, Chicago.

beams be protected by a minimum of 1½ ins. of concrete, and that the metal in floor slabs be protected by a minimum of 1 in. of concrete.

It is recommended that the corners of columns, girders and beams be leveled or rounded, as a sharp corner is more seriously affected by fire than a round one.

5. Waterproofing.

Many expedients have been used to render concrete impervious to water under normal conditions, and also under pressure conditions that exist in reservoirs, dams, and conduits of various kinds. Experience shows, however, that where mortar or concrete is proportioned to obtain the greatest practicable density and is mixed to a rather wet consistency, the resulting mortar or concrete is impervious under ordinary conditions. A concrete of dry consistency is more or less pervious to water, and compounds of various kinds have been mixed with the concrete or applied as a wash to the surface for the purpose of making it water tight. Many

quently the marks of the boards and the flat, dead surface are displeasing, making some special treatment desirable. A treatment of the surface which removes the film of mortar and brings the coarser particles of the concrete into relief is frequently used to remove the form markings, break the monotonous appearance of the surface, and make it more pleasing. Plastering of surfaces should be avoided, for the other methods of treatment are more reliable and usually much more satisfactory. Plastering, even if carefully applied, is likely to peel off under the action of frost or temperature changes.

VII. Design.

Massive Concrete.

In the design of massive concrete or plain concrete no account should be taken of the tensile strength of the material, and sections should usually be so proportioned as to avoid tensile stresses. This will generally be accomplished, in the case of rectangular

shapes, if the line of pressure is kept within the middle third of the section, but in very large structures, such as high masonry dams, a more exact analysis may be required. Structures of massive concrete are able to resist unbalanced lateral forces by reason of their weight, hence the element of weight rather than strength often determines the design. A relatively cheap and weak concrete will therefore often be suitable for massive concrete structures. Owing to its low extensibility, the contraction due to hardening and to temperature changes requires special consideration, and except in the case of very massive walls such as dams, it is desirable to provide joints at intervals to localize the effect of such contraction. The spacing of such joints will depend upon the form and dimensions of the structure and its degree of exposure.

Massive concrete may well be used for piers and short columns, in which the ratio of length to least width is relatively small. Under ordinary conditions this ratio should not exceed six, but where the central application of the load is assured a somewhat higher value may safely be used.



Concrete Pergola at Humboldt Park, Chicago.

Massive concrete is also a suitable material for arches of moderate span where the conditions as to foundations are favorable.

2. Reinforced Concrete.

By the use of metal reinforcement to resist the principal tensile stresses, concrete becomes available for general use in a great variety of structures and structural forms. This combination of concrete and steel is particularly advantageous in the beam, where both compression and tension exist; it is also advantageous in the column where the main stresses are compressive, but where cross-bending may exist. The theory of design will therefore relate mainly to the analysis of beams and columns.

3. General Assumptions.

(a) **Loads.**—The loads or forces to be resisted consist of:

1. The dead load, which includes the weight of the structure and fixed loads and forces.
2. The live load or the loads and forces which are variable. The dynamic effect of the live load will often require consideration. Any allowance for the dynamic effect is preferably taken into account by adding

the desired amount to the live load or to the live load stresses. The working stresses hereinafter recommended are intended to apply to the equivalent static stresses so determined.

In the case of high buildings the live load on columns may be reduced in accordance with the usual practice.

(b) **Lengths of Beams and Columns.**—The span length for beams and slabs shall be taken as the distance from the center to center of supports, but shall not be taken to exceed the clear span surplus the depth of beam or slab. Brackets shall not be considered as reducing the clear span in the sense here intended.

The length of columns shall be taken as the maximum unsupported length.

(c) **Internal Stresses.**—As a basis for calculations relating to the strength of structures, the following assumptions are recommended:

1. Calculations should be made with reference to working stresses and safe loads rather

than with reference to ultimate strength and ultimate loads.

2. A plane section before bending remains plane after bending.
3. The modulus of elasticity of concrete in compression within the usual limits of working stresses, is constant. The distribution of compressive stresses in beams is therefore rectilinear.
4. In calculating the moment of resistance of beams the tensile stresses in the concrete shall be neglected.
5. Perfect adhesion is assumed between concrete and reinforcement. Under compressive stresses the two materials are therefore stressed in proportion to their moduli or elasticity.
6. The ratio of the modulus of elasticity of steel to the modulus of elasticity of concrete may be taken at 15.
7. Initial stress in the reinforcement due to contraction or expansion in the concrete may be neglected.

It is appreciated that the assumptions herein given are not entirely borne out by experimental data. They are given in the interest of simplicity and uniformity, and variations from exact conditions are taken into

account in the selection of formulas and working stresses.

For calculations relative to deflections the tensile strength of the concrete should be taken into account. For such calculations, also, a value of 8 to 12 for the ratio of the moduli corresponds more nearly to the actual conditions and may well be used.

4. T-Beams.

In beam and slab construction, an effective bond should be provided at the junction of the beam and slab. When the principal slab reinforcement is parallel to the beam, transverse reinforcement should be used extending over the beam and well into the slab.

Where adequate bond between slab and web of beam is provided, the slab may be considered as an integral part of the beam, but its effective width shall be determined by the following rules:

- (a) It shall not exceed one-fourth of the span length of the beam;

several supports, due to uniformly distributed loads, the following rules are recommended:

- (a) That for floor slabs the bending moments at center and at support be taken at $\frac{wl^2}{12}$ for both dead and live loads, where w represents the load per linear foot and l the span length.

- (b) That for beams the bending moments at center and at support for interior spans be taken at $\frac{wl^2}{12}$, and for end spans they be taken at $\frac{wl^2}{12}$ for center and adjoining support, for both dead and live loads.

In the case of beams and slabs continuous for two spans only, or of spans of unusual length, more exact calculations should be made. Special consideration is also required in the case of concentrated loads.

Where beams are reinforced on the compression side, the steel may be assumed to carry its proportion



Concrete Seats and Lighting Pillars, Douglas Park, Chicago.

- (b) Its overhanging width on either side of the web shall not exceed 4 times the thickness of the slab.

In the design of T-beams acting as continuous beams, due consideration should be given to the compressive stresses at the support.

5. Floor Slabs.

Floor slabs should be designed and reinforced as continuous over the supports. If the length of the slab exceeds 1.5 times its width, the entire load should be carried by transverse reinforcement. Square slabs may well be reinforced in both directions.*

The loads carried to beams by slabs which are reinforced in two directions will not be uniformly distributed to the supporting beam and may be assumed to vary in accordance with the ordinates of a triangle. The moments in the beams should be calculated accordingly.

6. Continuous Beams and Slabs.

When the beam or slab is continuous over its supports, reinforcement should be fully provided at points of negative moment. In computing the positive and negative moments in beams and slabs continuous over

of stress in accordance with the provisions of Article VII, Section 3, cl. 6. In the case of continuous beams, tensile and compressive reinforcement over supports must extend sufficiently beyond the support to develop the requisite bond strength.

* The exact distribution of load on square and rectangular slabs, supported on four sides and reinforced in both directions, cannot readily be determined. The following method of calculation is recognized to be faulty, but it is offered as a tentative method which will give results on the safe side. The distribution of load is first to be determined by the formula

$$r = \frac{l^4}{l^4 + b^4}$$

in which r = proportion of load carried by the transverse reinforcement, l = length and b = breadth of slab. For various ratios of l | b the values of r are as follows:

l | b	r
1.0	0.50
1.1	0.59
1.2	0.67
1.3	0.75
1.4	0.80
1.5	0.83

Using the values above specified, each set of reinforcement is to be calculated in the same manner as slabs having supports on two sides only, but the total amount of reinforcement thus determined may be reduced 25 per cent. by gradually increasing the rod spacing from the third point to the edge of the slab.

7. Bond Strength and Spacing of Reinforcement.

Adequate bond strength should be provided in accordance with the formula hereinafter given. Where a portion of the reinforcement is bent up near the end of a beam, the bond stress in the remaining straight reinforcement will be less than is represented by the theoretical formula.

Where high bond resistance is required, the deformed bar is a suitable means of supplying the necessary strength. Adequate bond strength throughout the length of a bar is preferable to end anchorage, but such anchorage may properly be used in special cases. Anchorage furnished by short bends at a right angle is less effective than hooks consisting of turns through 180°.

The lateral spacing of parallel bars should not be less than 2.5 diameters center to center, nor should the distance from the side of the beam to the center of the nearest bar be less than 2 diameters. The clear spacing between two layers of bars should not be less than 1/2 in.

8. Shear and Diagonal Tension.

Calculations for web resistance shall be made on the basis of maximum shearing stress as determined by the formulas hereinafter given. When the maximum shearing stress exceed the value allowed for the concrete alone, web reinforcement must be provided to aid in carrying the diagonal tensile stress. This web reinforcement may consist of bent bars, or inclined or vertical members attached to or looped about the horizontal reinforcement. Where inclined members are used, the connection to the horizontal reinforcement shall be such as to insure against slip.

Experiments bearing on the design of details of web reinforcement are not yet complete enough to allow more than general and tentative recommendations to be made. It is well established, however, that a very moderate amount of reinforcement, such as is furnished by a few bars bent up at small inclination, increases the strength of a beam against failure by diagonal tension to a considerable degree; and that a sufficient amount of web reinforcement can readily be provided to increase the shearing resistance to a value from three or more times that found when the bars are all horizontal and no web reinforcement is used. The following allowable values for the maximum shearing stress are therefore recommended, based on the working stresses of Article VIII, p. 252:

- (a) For beams with horizontal bars only 40 lbs. per sq. in.
- (b) For beams in which a part of the horizontal reinforcement is used in the form of bent-up bars, arranged with due respect to the shearing stresses, a higher value may be followed, but not exceeding 60 lbs. per sq. in.
- (c) For beams thoroughly reinforced for shear a value not exceeding 120 lbs. per sq. in.

In the calculation of web reinforcement to provide the strength required under (c) above, the concrete may be counted upon as carrying one-third of the shear. The remainder is to be provided for by means of metal reinforcement consisting of bent bars or stirrups, but preferably both. The requisite amount of such reinforcement may be estimated on the assumption that the entire shear on a section, less the amount assumed to be carried by the concrete, is carried by the reinforcement in a length of beam equal to its depth.

The longitudinal spacing of stirrups or bent rods

shall not exceed three-fourths the depth of the beam.

It is important that adequate bond strength be provided to develop fully the assumed strength of all shear reinforcement.

Inasmuch as small deformations in the horizontal reinforcement tends to prevent the formation of diagonal cracks, a beam will be strengthened against diagonal tension failure by so arranging the horizontal reinforcement that the unit stresses at points of large shear shall be relatively low.

9. Columns.

It is recommended that the ratio of unsupported length of column to its least width be limited to 15.

The effective area of the column shall be taken as the area within the protective covering, as defined in Article VI, Section 4, or in the case of hooped columns or columns reinforced with structural shapes it shall be taken as the area within the hooping or structural shapes.

Columns may be reinforced by means of longitudinal bars, by bands or hoops, by bands or hoops together with longitudinal bars, or by structural forms which in themselves are sufficiently rigid to act as columns. The general effect of bands or hoops is to greatly increase the "toughness" of the column and its ultimate strength, but hooping has little effect upon its behavior within the limit of elasticity. It thus renders the concrete a safer and more reliable material and should permit the use of a somewhat higher working stress. The beneficial effects of "toughening" are adequately provided by a moderate amount of hooping, a larger amount serving mainly to increase the ultimate strength and the possible deformation before ultimate failure.

The following recommendations are made for the relative working stresses in the concrete for the several types of columns:

- (a) Columns with longitudinal reinforcement only, the unit stress recommended for axial compression in Article VIII, Section 3.
- (b) Columns with reinforcement of bands or hoops, as hereinafter specified, stresses 20 per cent. higher than given for (a).
- (c) Columns reinforced with not less than 1 per cent. and not more than 4 per cent. of longitudinal bars and with bands or hoops, stresses 45 per cent. higher than given for (a).
- (d) Columns reinforced with structural steel column units which thoroughly encase the concrete core, stresses 45 per cent. higher

than given for (a).

In all cases longitudinal reinforcement is assumed to carry its proportion of stress in accordance with Section 3. The hoops or bands are not to be counted upon directly as adding to the strength of the column.

Bars composing longitudinal reinforcement shall be straight and shall have sufficient lateral support to be securely held in place until the concrete has set.

Where bands or hoops are used, the total amount of such reinforcement shall be not less than 1 per cent. of the volume of the column enclosed. The clear spacing of such bands or hoops shall be not greater than one-fourth the diameter of the enclosed column. Adequate means must be provided to hold bands or hoops in place so as to form a column, the core of which shall be straight and well centered.

Bending stresses due to eccentric loads must be provided for by increasing the section until the maximum stress does not exceed the values above specified.

10. Reinforcing for Shrinkage and Temperature Stresses.

Where large areas of concrete are exposed to atmospheric conditions, the changes of form due to shrinkage (resulting from hardening) and to the action of temperature are such that large cracks will occur in the mass, unless precautions are taken to so distribute the stresses as either to prevent the cracks altogether or to render them very small. The size of the cracks will be directly proportional to the diameter of the reinforcing bars and inversely proportional to the per centage of reinforcement and also to its bond resistance per unit or surface area. To be most effective, therefore, reinforcement should be placed near the exposed surface and well distributed, and a form of reinforcement used which will develop a high bond resistance.

VIII. Working Stresses.

1. General Assumptions.

The following working stresses are recommended for static loads. Proper allowances for vibration and impact are to be added to live loads where necessary to produce an equivalent static load before applying the unit stresses in proportioning parts.

In selecting the permissible working stress to be allowed on concrete, we should be guided by the working stresses usually allowed for other materials of construction, so that all structures of the same class but composed of different materials may have approximately the same degree of safety.

The stresses for concrete are proposed for concrete composed of one part Portland cement and six parts of aggregate, capable of developing an average compressive strength of 2,000 lbs. per sq. in. at 28 days, when tested in cylinders 8 ins. in diameter and 16 ins. long, under laboratory conditions of manufacture and storage, using the same consistency as is used in the field. In considering the factors recommended with relation to this strength, it is to be borne in mind that the strength at 28 days is by no means the ultimate which will be developed at a longer period, and therefore they do not correspond with the real factor of safety. On concretes in which the material of the aggregate is inferior, all stresses should be proportionally reduced, and similar reduction should be made when leaner mixes are to be used. On the other hand, if, with the best quality of aggregates, the richness is increased, an increase may be made in all working stresses proportional to the increase in compressive strength at 28 days, but this increase shall not exceed 25 per cent.

2. Bearing.

When compression is applied to a surface of concrete larger than the loaded area, a stress of 32.5 per cent. of the compressive strength at 28 days, or 650 lbs. per sq. in. on the above described concrete, may be allowed. This pressure is probably unnecessarily low when the ratio of the stressed area to the whole area of the concrete is much below unity, but is recommended for general use rather than a variable unit based upon this ratio.

3. Axial Compression.

For concentric compression on a plain concrete column or pier, the length of which does not exceed 12 diameters, 22.5 per cent. of the compressive strength at 28 days, or 450 lbs. per sq. in. for 2,000-lb. concrete, may be allowed.

For other forms of columns the stresses obtained from the ratios given in Article VII, Section 9, may govern.

4. Compression in Extreme Fiber.

The extreme fiber stress of a beam, calculated on the assumption of a constant modulus of elasticity for concrete under working stresses, may be allowed to reach 32.5 per cent. of the compressive strength at 28 days, or 650 lbs. per sq. in. for 2,000-lb. concrete. Adjacent to the support of continuous beams, stresses 15 per cent. higher may be used.

5. Shear and Diagonal Tension.

Where pure shearing stress occurs, that is, uncombined with compression normal to the shearing surface, and with all tension normal to the shearing plane provided for by reinforcement, a shearing stress of 6 per cent. of the compressive strength at 28 days, or 120 lbs. per sq. in. for 2,000-lb. concrete, may be allowed. Where the shear is combined with an equal compression, as on a section of a column at 45° with the axis, the stress may equal one-half the compressive stress allowed. For ratios of compressive stress to shear intermediate between 0 and 1, proportionate shearing stress shall be used.

In calculations on beams in which diagonal tension is considered to be taken by the concrete, the vertical shearing stresses should not exceed 2 per cent. of the compressive strength at 28 days, or 40 lbs. per sq. in. for 2,000-lb. concrete.

6. Bond.

The bonding stress between concrete and plain reinforcing bars may be assumed at 4 per cent. of the compressive strength at 28 days, or 80 lbs. per sq. in. for 2,000-lb. concrete, and in the case of drawn wire 2 per cent., or 40 lbs. per sq. in. for 2,000-lb. concrete.

7. Reinforcement

The tensile stress in steel should not exceed 16,000 lbs per sq. in. The compressive stress in reinforcing steel should not exceed 16,000 lbs. per sq. in., or 15 times the working compressive stress in the concrete.

In structural steel members the working stresses adopted by the American Railway Engineering and Maintenance of Way Association are recommended.

8. Modulus of Elasticity.

The value of the modulus of elasticity of concrete has a wide range, depending upon the materials used, the age, the range of stresses between which it is considered, as well as other conditions. It is recommended that in all computations it be assumed as one-fifteenth that of steel, as, while not rigorously accurate, this assumption will give safe results.

CEMENT MILL NEWS.

The plant of the York Portland Cement Co., Portsmouth, O., was sold recently to the Empire Portland Cement Company of Kansas City, Mo.

The Lumbermen's Portland Cement and Brick Company of Carlyle, Kans., now in the hands of the federal court will soon be reorganized and its plant completed. Henry M. Beardsley of Kansas City secured a charter for the reorganized company. It has a capital of \$1,250,000. The incorporators are J. M. Byrne and W. E. Wood, of Kansas City, Mo., F. L. Eberhart, Salina, Kans., C. H. Apt, Iola, Kans., B. V. Sloan, Huron, Kans., and W. H. Jasper, Newton, Iowa.

The Paragon Plaster Co., Syracuse, N. Y., will enlarge their plaster plant at an early date.

Amos Kendall who was formerly traveling salesman for the Omega Portland Cement Co., Jonesville, Mich., was recently appointed general manager and treasurer of the company

The Cowell Portland Cement Company's plant at Cowell, Cal., has been closed for repairs and will not resume work before the first of March. Considerable new machinery is being installed in the raw material department.

President A. F. Coats of the Washington Portland Cement Co., Seattle, Wash., has determined to practically treble the capacity of his plant at Concrete, Wash. The output of the plant will be increased from 850 to 2,200 barrels per day by March 1.

NEW CEMENT MILLS.

The Pacific Coast Gypsum Co., Tacoma, Wash., will build an additional plant in Canada to handle its plaster business there. Mr. W. R. Nichols is manager of the company.

The cement plant of the Golden State Portland Cement Co., which has been building for some time at Oro Grande, Cal., has finally reached the manufacturing stage and is turning out 1000 barrels of cement a day. The second kiln will be installed shortly, doubling the present production of the plant.

Chas. Page, Tulsa, Okla., and associates are planning the organization of a \$250,000 company to build a Portland Cement plant.

The big cement plant at Ragland, Ala., is to be augmented by the addition of a plant for the manufacture of terra cotta for piping and ornamental purposes. The expenditure will be \$250,000.

Application for the incorporation of what is to be known as the Kelly Gypsum Co., Sandusky, Ohio, a concern with a capital stock of \$150,000 was forwarded to the Secretary of state at Columbus, Ohio, by the incorporators, S. C. Kelly, Wm. L. Allendorf, John B. Swift, and Paul H. Sprow, all of Sandusky. A \$75,000 gypsum plant is to be erected near Castalia, at once.

The Canadian Portland Cement Co., Ltd., of Toronto, Ont., one of the largest concerns in the Dominion, has secured a valuable property in Winnipeg, and will commence construction of a cement mill in the spring. The mill will be ready for operation early in 1912.

Balfour, Guthrie & Co., 510 Central Bldg., Seattle, Wash., have secured a site of 40 acres at Bellingham, Wash., for the erection of a cement plant there, according to press reports.

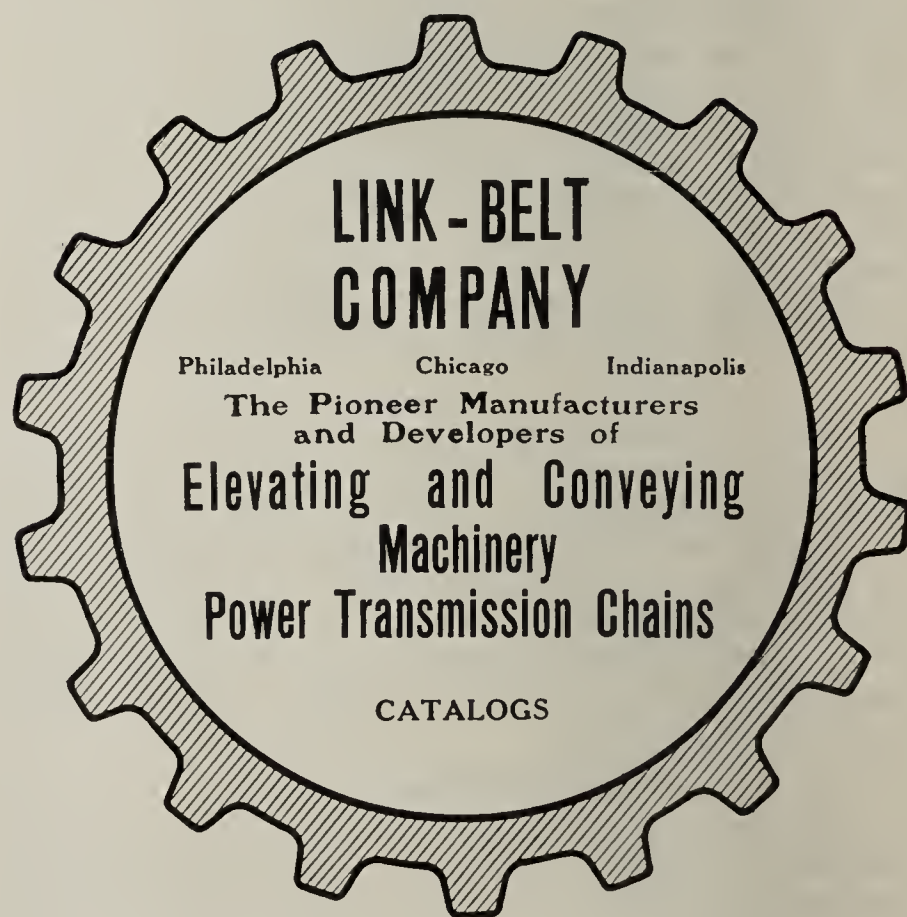
GROWTH OF THE NORTHWESTERN STEEL AND IRON WORKS.

The steady growth of the Northwestern Steel and Iron Works at Eau Claire, Wisconsin, is a reliable sign of the prosperity attending the manufacture of concrete machinery. During 1911 they added to their plant another foundry, 200 feet long by 100 feet wide,

giving room for one hundred additional moulders. They also added three new buildings to their manufacturing plant and very extensively to their machinery equipment.

The illustration in their advertisement on page 91 gives a view of the plant of the Northwestern Steel and Iron Works, the largest factory in the world devoted to the manufacture of concrete machinery. It has a moulding capacity of fifteen tons of iron per day and extensive floor space. Their workmen, who are experts in the concrete machinery line, mix a special grade of iron for this class of work. Their pattern makers and carvers make nothing but concrete machinery patterns, plates and moulds. They operate their own cast iron and brass foundries, machine shops, forge shops, pattern shop and grinding rooms. The plant is constructed particularly to build concrete machinery and is equipped in the most up-to-date manner. These facilities enable them to turn out work in large quantities successfully and at a minimum cost. They are naturally in a position to negotiate for the manufacture of anything in their line and for large or small contracts. They figure their prices by the pound and charge nothing on account of patents, territory rights, etc.

The makers of Northwestern Concrete machinery are specialists in their line. They maintain an Information Bureau which is at the service of all customers. New moulds and machinery are being made continually and it is their experience that users of concrete machinery appreciate this opportunity to learn about new products. As some mould or machine may be just what a worker in concrete needs, they urge everyone who is interested in their line to make use of this Information Bureau free of charge. If a customer will explain his peculiar needs, the Information Bureau will help him to keep up with the times. Machines and moulds



are put on the market only after long test; everyone is carefully inspected before leaving the factory and is fully guaranteed. Precautions are taken to serve the individual's requirements; only such machines or moulds as will best serve the customer's purpose are recommended. Every shipment is carefully followed up to insure prompt delivery. Nothing, in fact, is left undone to satisfy customers.

The large wholesale catalog on concrete machinery for 1911, published by the Northwestern Steel and Iron Works, has recently come from the press. It is a large volume containing hundreds of fine illustrations made from actual photographs and describes practically everything required in this line. It is for free distribution. The book will be valuable for reference to everyone interested in concrete, from the biggest contractor to the smallest concrete worker. Write to them for it.

THE SCHENK-STEWART LINE CONCRETE MACHINERY

The Schenk-Stewart Line of Concrete Machinery and Equipment is built upon a foundation of good principles and ideas bonded together with experience and mounted upon a base of "quality". Every machine and every piece of equipment in the S. & S. Line is the outcome of good hard study and experience—no device and no idea is ever adopted until it has passed a stringent mechanical inspection and has proven itself of value and advantage by an actual operating test.

The prime object in manufacturing the S. & S. Line is to produce machinery and equipment which will stand the every day "knocks" and abuses—every day service which will tend to assist in the success of the user.

The ultimate thought has been to decrease the cost of upkeep, increase the efficiency and assure entire satisfaction. Factory cost and selling price has been a second consideration and we say to you, who are about to purchase concrete machinery and equipment, look well, and be sure that the trade mark S. & S. is connected in some way with the article of your choice for this mark is nothing short of insurance against poor workmanship, material and principle—a guarantee of success.

The S. & S. Line

The Schenk-Stewart Line of Concrete Machinery and Equipment includes the well known Schenk Cement Drain Tile Machine, The Perfection Concrete Mixers, The Four-Way Block Machine, Ideal Brick, Block and Transfer Cars, Easy Hand Tile Molds, American Steel Tanks, Sand Screens, Dump Cars, Dump Wagons, Elevators, Friction Hoists, Post Machines, Brick Machines, Crushers, Material Washers, Gasoline Engines, Steam Engines, Boilers, Ornamental Molds, Grinders and a full line of Cement Tools. Therefore, we feel confident that we can comply with your every want.

We make a specialty of designing and equipping complete plants for the manufacture of concrete products—teaching you the business from A to Z. Having designed and equipped some of the best and largest plants in the country our co-operation with you on this particular subject will, we are sure, be of mutual benefit.

It would be impossible to tell you all about the S. & S. Line, the factory that builds it and the men behind it in this advertisement, so we ask that you send us your name and address on your business letter head and by return mail we will place in your hands the complete story which can be reviewed at your convenience. Better sit right down and do it now—while the matter is fresh in your mind.

The Cement Tile Machinery Co.

"Creators of the Cement Drain Tile Industry"

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Will You Let Us Send You FREE a New HAND BOOK on Concrete Brick and Block Making?

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| —Plant arrangement | —A waterproof building system fully illustrated |
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It has cost a lot of money and time to gather this valuable information and while we should sell this book for no small sum, we are even asking if we may mail it to you **Absolutely Free**. There is data in it which will make you keep it for years. You would not be without it.

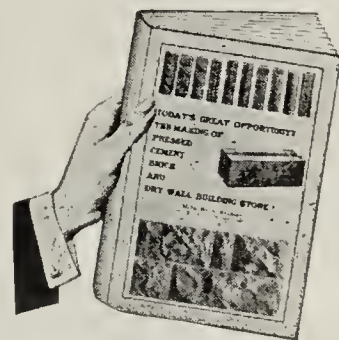
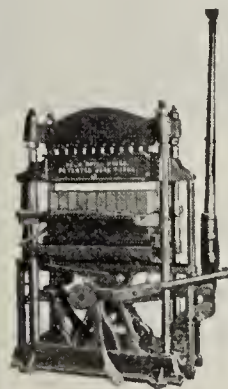
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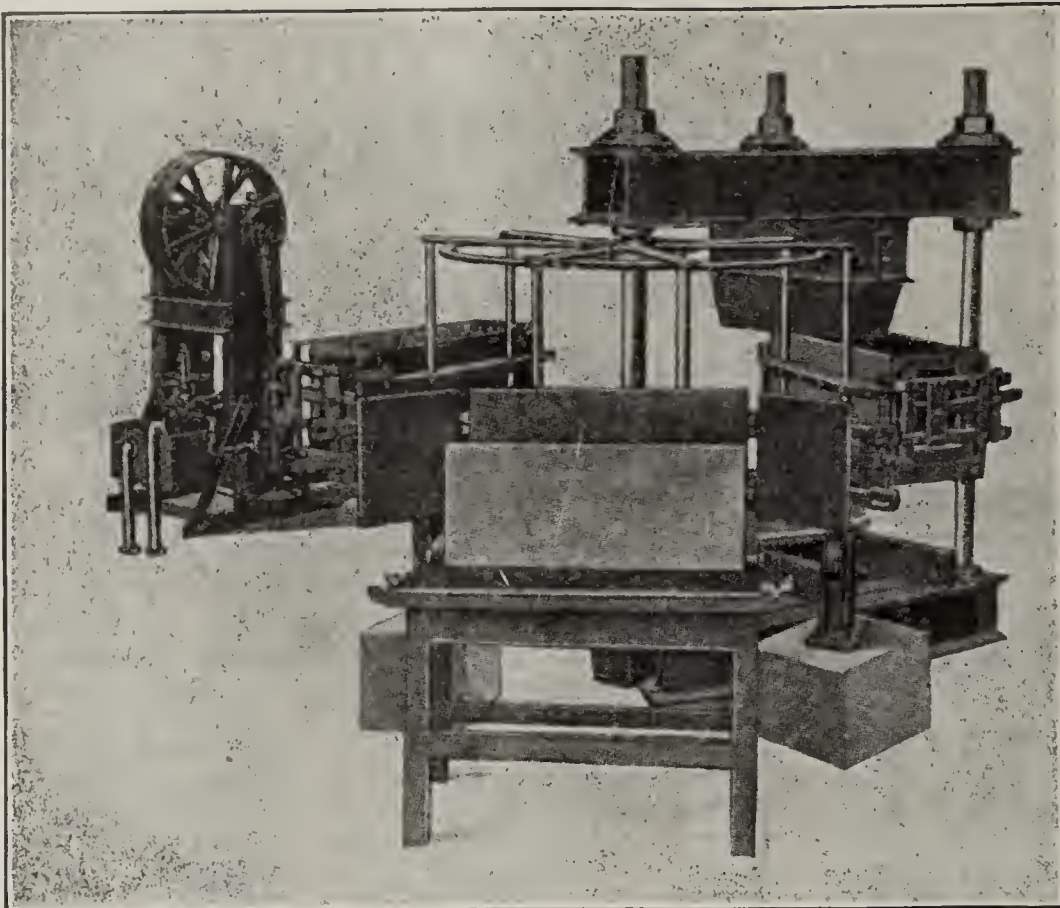
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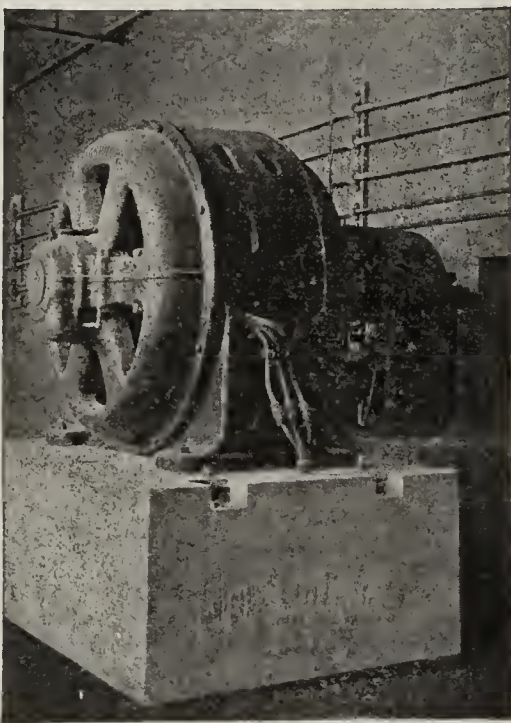
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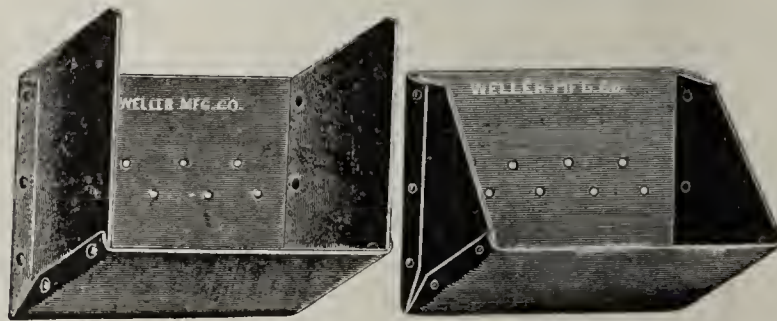
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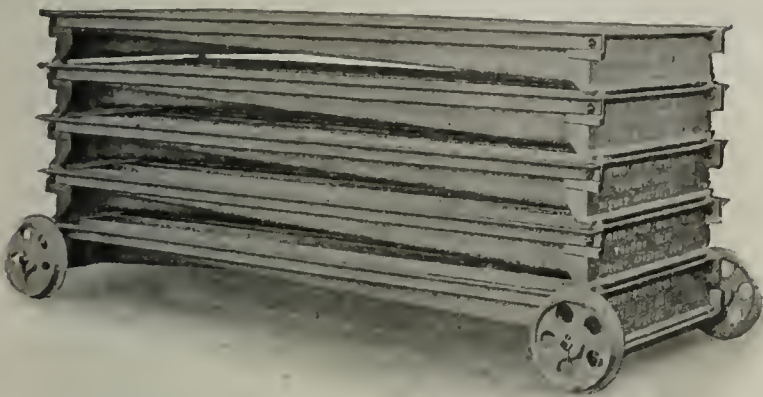
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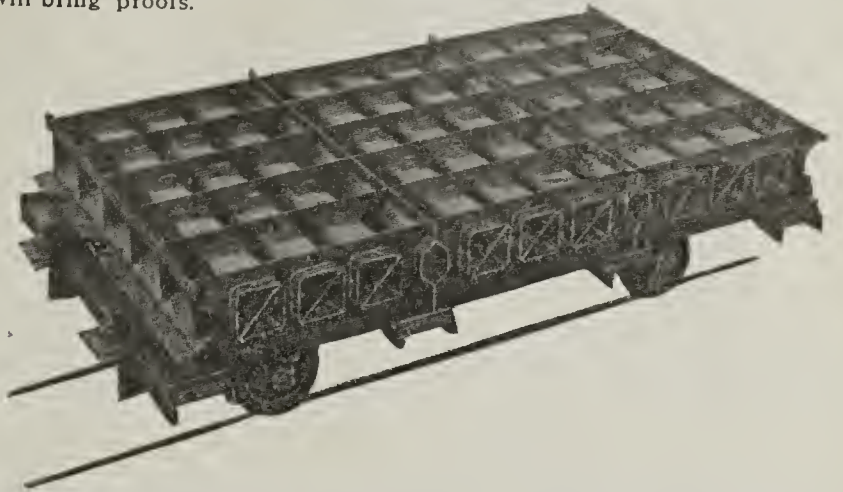
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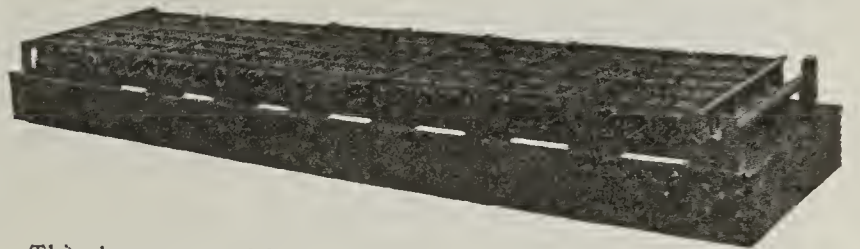
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This roller bearing, all steel car contains fifteen 8x8x24 inch rock faced molds, NO TWO FACES ALIKE. These molds are so PERFECTLY CONSTRUCTED that the faces of blocks are guaranteed not to vary the ONE-HUNDREDTH PART of AN INCH IN SIZE. THE CORES pass through from one side of the car to the other; they are NONTAPERING AND COLLAPSIBLE and withdraw with perfect ease after cement has set. Wherever this system is introduced it simply ANNIHILATES all other systems of block making. It is THOROUGHLY PROTECTED by PATENTS which enable us to give EXCLUSIVE TERRITORY. Secure your own city BEFORE SOMEONE ELSE DOES and get into A BUSINESS THAT PAYS. This is positively the best Cement proposition in the United States today. Price of fifteen-mould car as shown above, \$80.00. The difference in price block made by our system sell for, over all other block, will pay for cars three times OVER IN ONE YEAR. Look this up. DO IT NOW. Send for catalogue.



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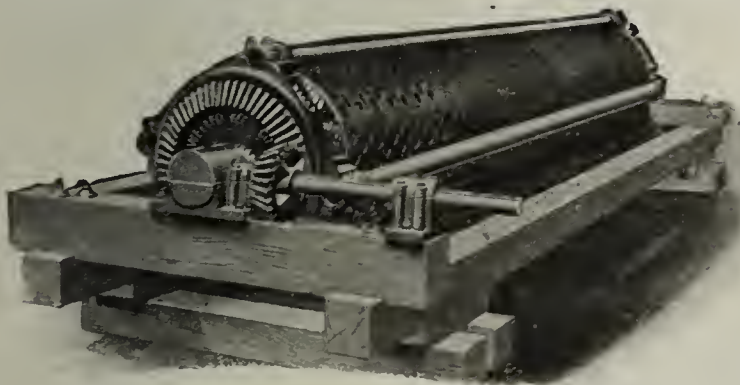
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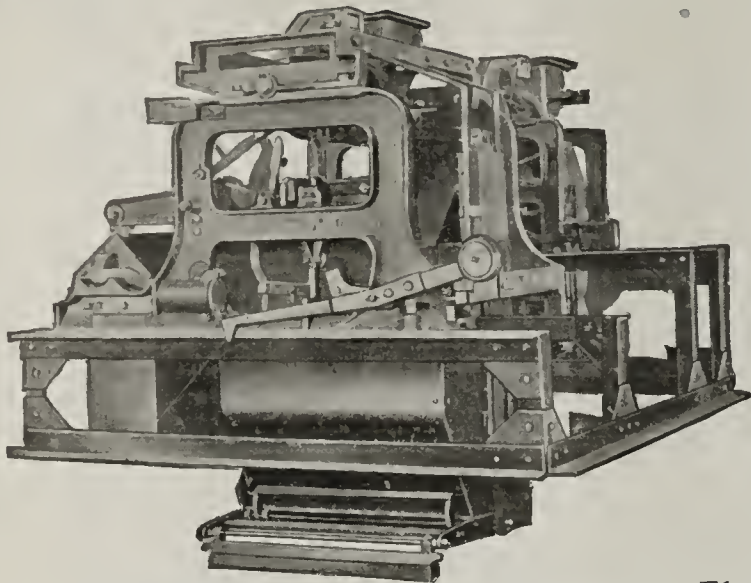
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In order that the users of waterproof cement may be informed in the premises, we desire to call attention to the fact that the

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is the owner of certain original letters patent for waterproofing Portland cement and the process of making the same, and that it is the intention of this company to protect its rights under these letters patent and prosecute manufacturers and users of waterproofing material who infringe any of them. In pursuance of this policy we have brought suit against

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We further wish to notify the trade that our letters patent antedate the letters patent under which any of the above named parties against whom we have brought suit profess to be operating.

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If you want a brick machine that will turn out a superior product at low labor cost—a product enabling you to compete in open market with the clay brick men—investigate

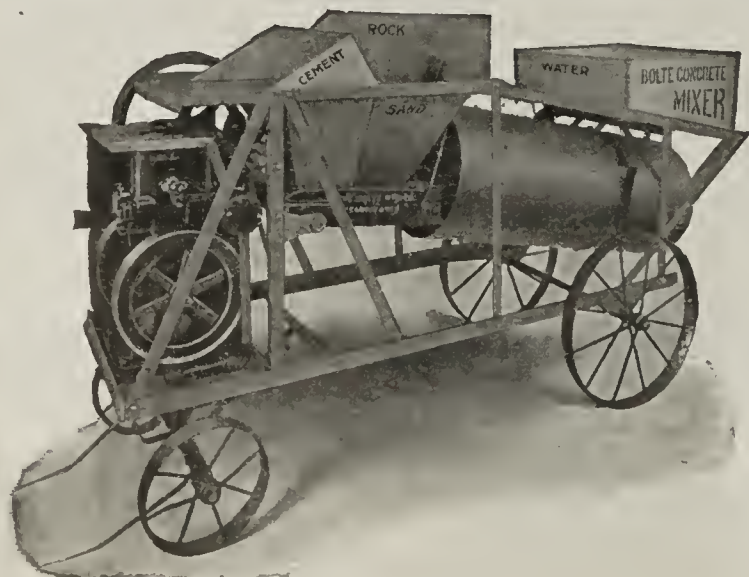
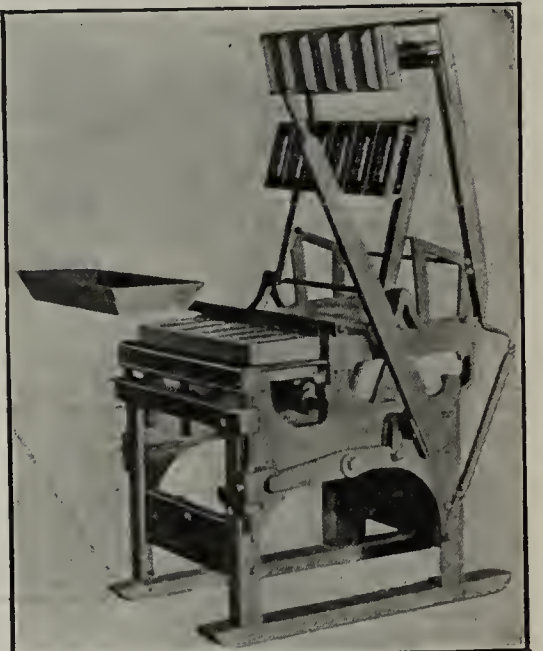
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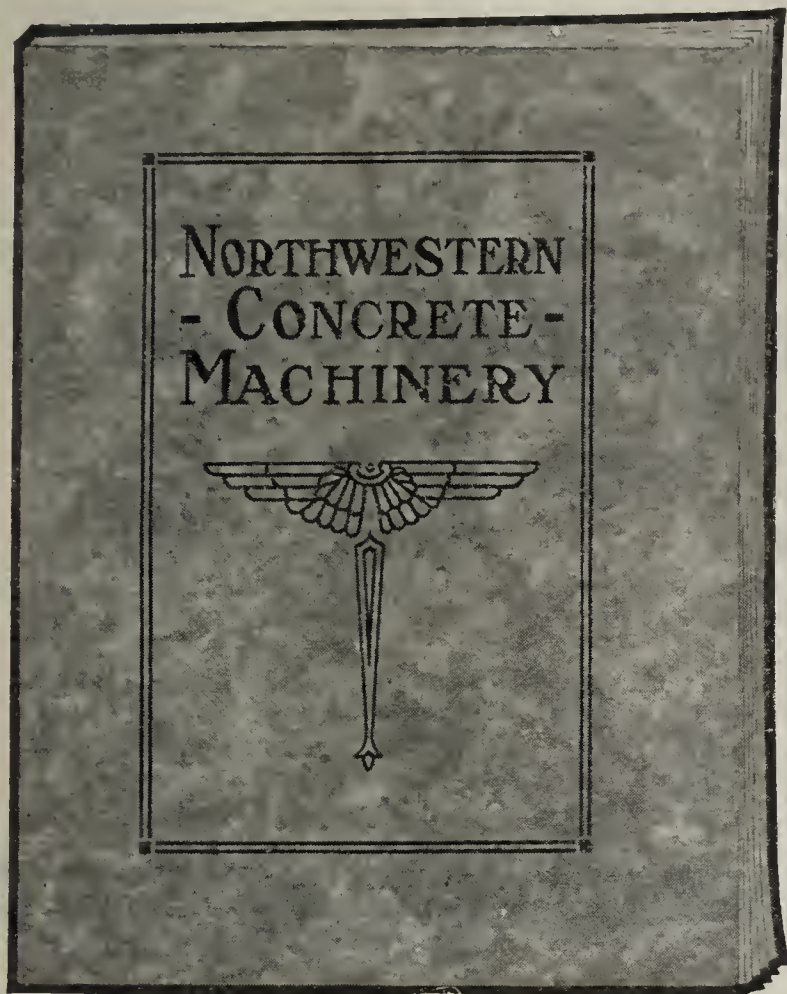
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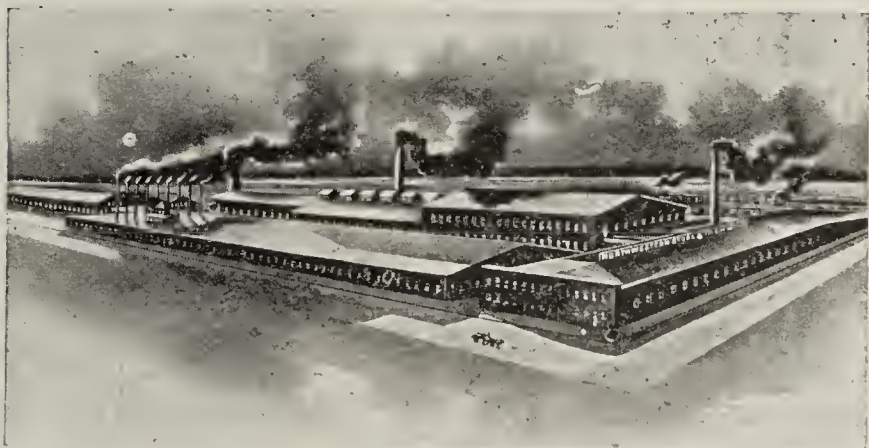
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IT WILL PAY YOU TO USE CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

Marblehead Lime Company

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Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

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These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

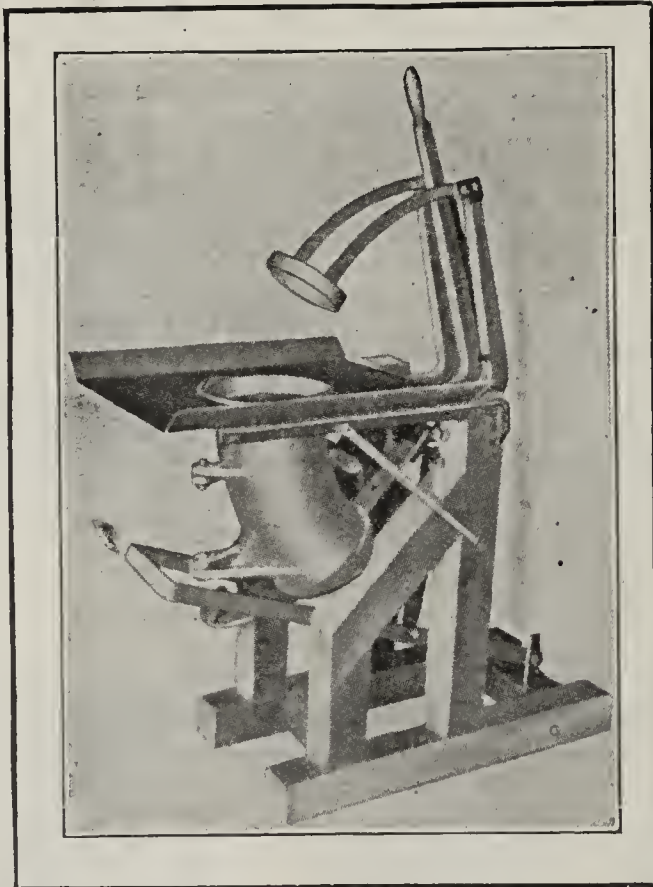
Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

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Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
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Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
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The Latest Thing
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ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

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At Gary, Ind., the steel center of the west, the United States Steel Corporation will build hundreds of homes for the employees of its big mills. After an exhaustive investigation, the officials and engineers in charge decided that monolithic concrete dwellings—foundations, walls, partitions, floors and roofs— could be built most cheaply and most satisfactorily with REICHERT METAL FORMS. Actual construction work began in December, 1910.

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Reichert Metal Forms for Monolithic Concrete Work

will save from 3 to 5c. per sq. ft. of wall
on practically any type of monolithic construction.

See our exhibit at the Chicago Show (booths 217 and 218), or
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save enough on lumber and labor to PAY FOR THEMSELVES IN HALF A SEASON.

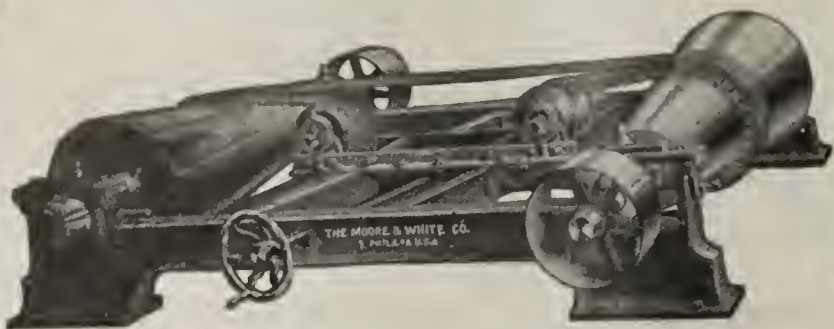
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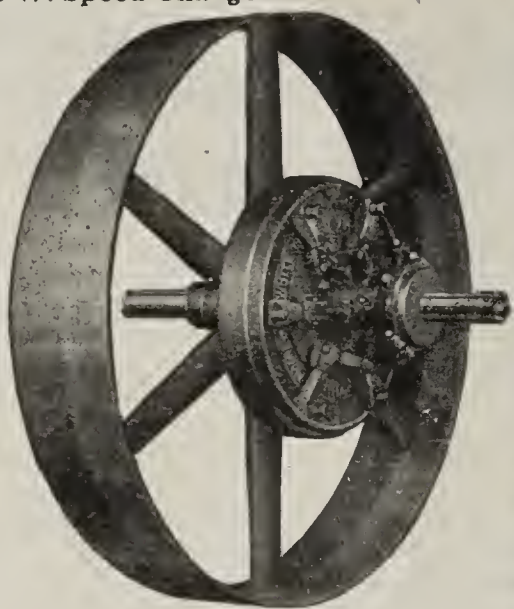
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M. & W. Speed Change.

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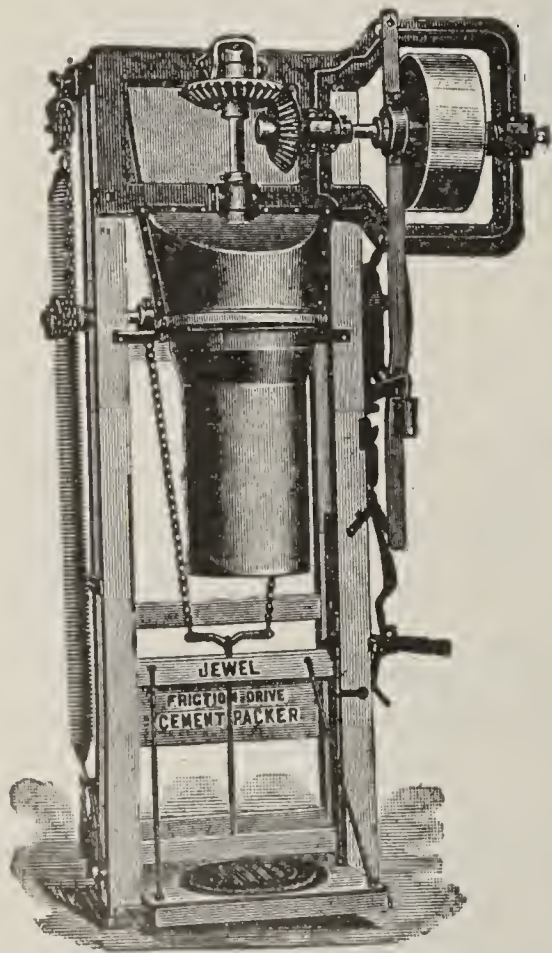
which are unequalled, the strategic location of our plants with reference to freight transportation, our enormous storage capacity, our methods of manufacture which represent the highest development in Portland cement making, the use of the purest and most uniform of raw materials, and our strict compliance with all contracts are the important factors in the growth of our output from 32,000 barrels in 1900 to 8,000,000 barrels in 1910.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

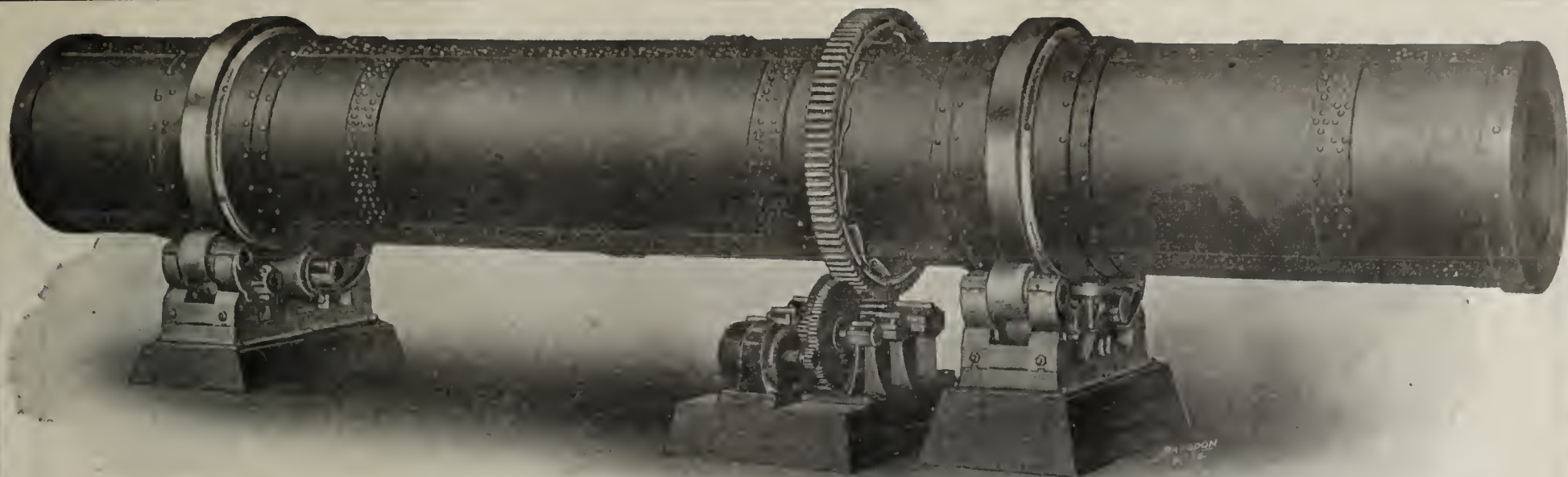
The "JEWEL" FRICITION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

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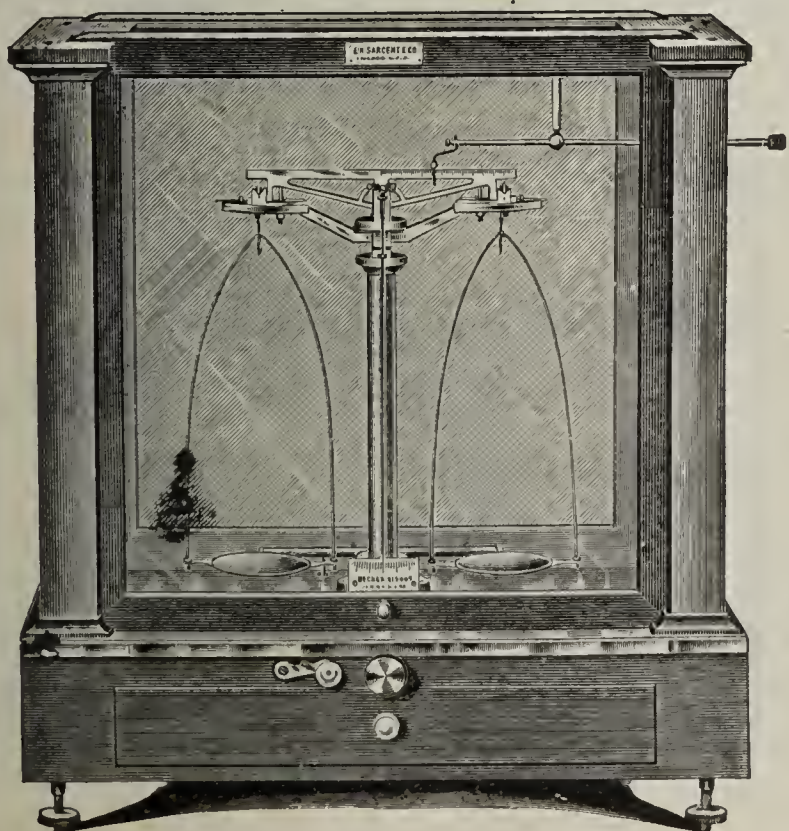
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We send catalogue without charge to responsible parties.

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A beautiful product adapted to ornamental artificial stone work of the highest grade. Equal or superior to any other White Portland Cement known.

Write for free sample, pamphlet with instructions for use and price.



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(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents efflorescence and discoloration. Gives absolutely permanent results and does not affect strength, setting or color of Portland Cement.

Used by nearly all the foremost Engineers, Architects, Railways, Contractors, Block Makers and Cement Experts.

Obtain our price and circular, also price on Medusa Gray Portland Cement.

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.

"VULCANITE" PORTLAND CEMENT

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Land Title Building
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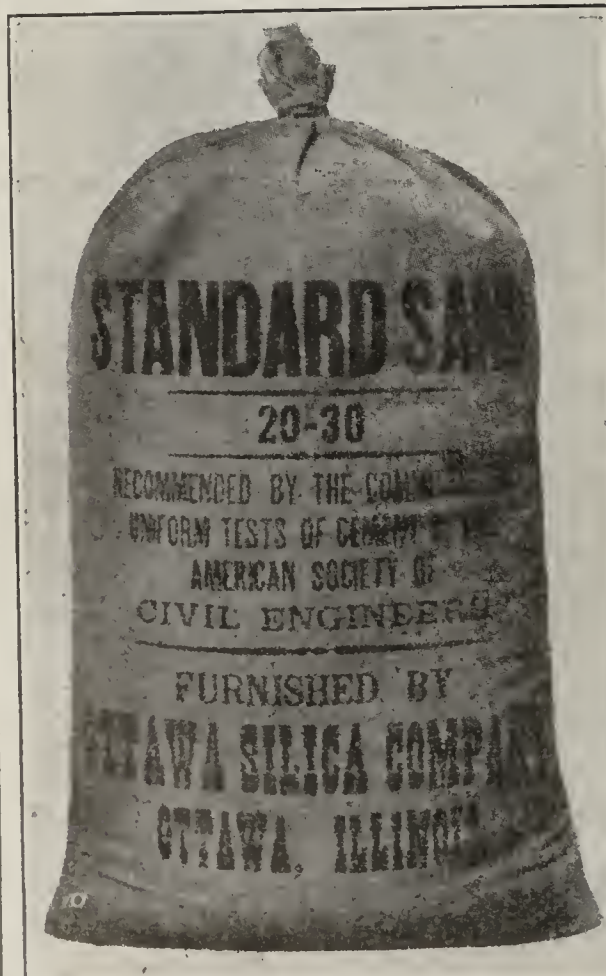
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Unexcelled for facing concrete blocks, ornamental concrete stone, etc.

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Prices, Freight Rates and Samples on Application.

You can order less than a carload, in fact shipments as small as five 175 lb. bags can be delivered economically.

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Are you making any money in your Concrete business, or do you have trouble from want of information on best methods? If you need advice on any Concrete job, write me, tell me what you are up against, as I have been working in Concrete since 1873 and should know something about the business by this time and most likely can help you. If I cannot, I will tell you so. My charges for Waterproofing formula is \$2.00, or for other information, unless for large work that requires more attention. Reasonable charges for large operations. Special information on constructing dams, water works wells, method of sinking large wells and foundations in soft earth or water, Iron reinforced Concrete construction, Terazzo floors, and engineering difficulties, working Concrete in freezing weather, under cut work, elastic moulds for making statuary, making moulds for garden vases and getting up the patterns.

I conduct a correspondence course in Concrete by mail for a limited number of pupils for \$20.00, which includes my waterproofing formulas coloring and compound for making blocks harder after made, it saves you the cost on one job. Get your information from one who has done the actual WORK.

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Fire Brick Linings For Cement Kilns

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Chemist, college graduate, who has been many years in charge of Portland Cement Laboratories and who is thoroughly familiar with Portland Cement manufacture, wants position. Best of references. Address M. A., care Cement & Engineering News.

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The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

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Denatured Alcohol in Solid Form.

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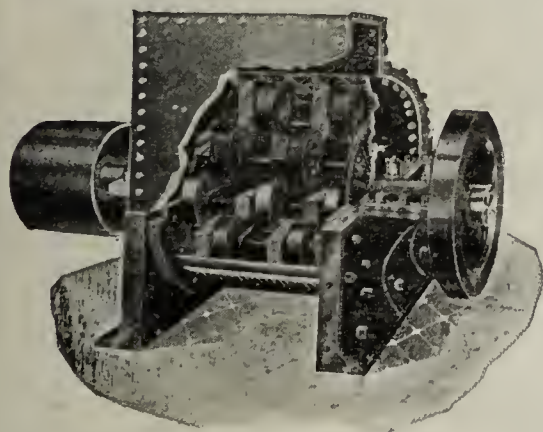
A sample case containing 50 solid cubes, a stove and the secret formula, how simple it can be made at home, will be mailed to you post paid on receipt of \$5.00, or C. O. D. Address:

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DISTILLERIES Co., Inc.

Dept. C. Wheeling, W. Va., U. S. A.

American Ring-Hammer Pulverizer



Six Sizes.

will pulverize

Cement, Clinker, Shale, Limestone, Coal, Etc.

30 days' working test at your works allowed. Machines guaranteed
All Grinding Parts Made of MANGANESE STEEL.

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The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
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and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

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Other materials in proportion.

It saves cost in buildings.

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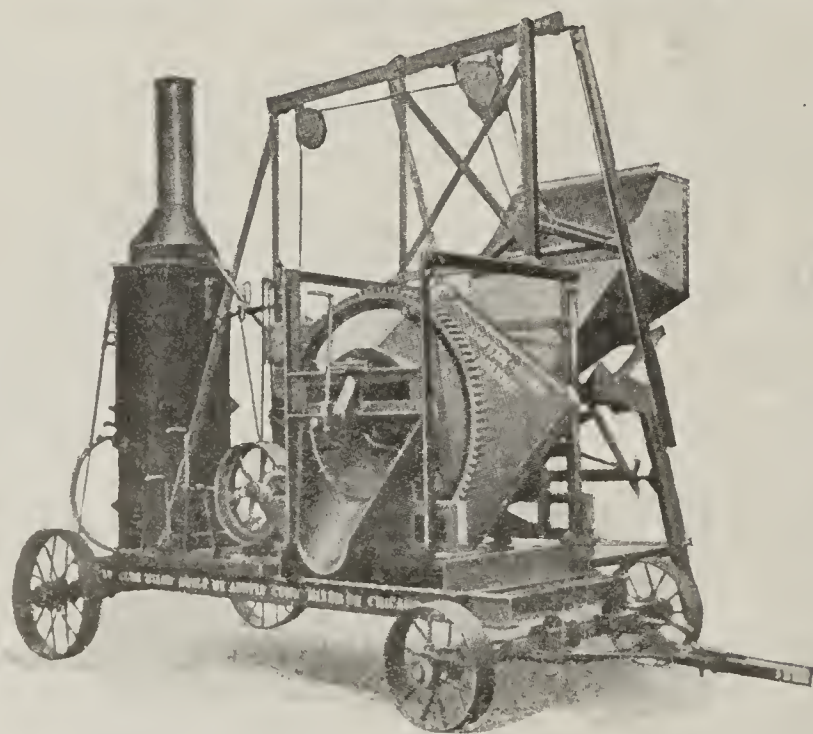
BRADLEY PULVERIZER CO.

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BOSTON



The United States Government



operates an official testing laboratory at St. Louis, Mo. At the laboratory it makes beams, columns and blocks, some of plain concrete and others of concrete reinforced in various ways, and tests them, comparing the tests one with another. By this comparison it establishes the relative values of various amounts and forms of reinforcement.

Now to compare the value of one form of reinforcement with another it is plain that, except for the reinforcement, the sample beams or columns must be identical. The concrete mixture must be the same today, next week, a month from now; uniformity absolute and invariable must exist. When, therefore, the director of the laboratory states that "all concrete is mixed in three cube mixers," the statement is significant. The cube, mixing its batch by a kneading process, produces the most uniform and homogeneous concrete of

any type of concrete mixer, THE AUSTIN CUBE MIXER, by its improvement, adds to this property large output and cheap operation. It is therefore the best mixer for the constructing engineer and contractor, as well as for the testing laboratory. Send for catalog No. 5

Austin Cube Mixer Company

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THE IMPROVED DIETRICH'S CLAMP and

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By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

COST OF CONCRETE CONSTRUCTION IS REDUCED 50%

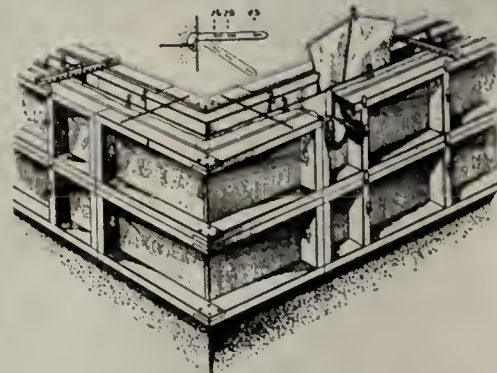
and the builder also secures a

PERFECT DAMP-PROOF WALL

This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

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SPIRAL CONVEYOR

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Catalog for the asking.

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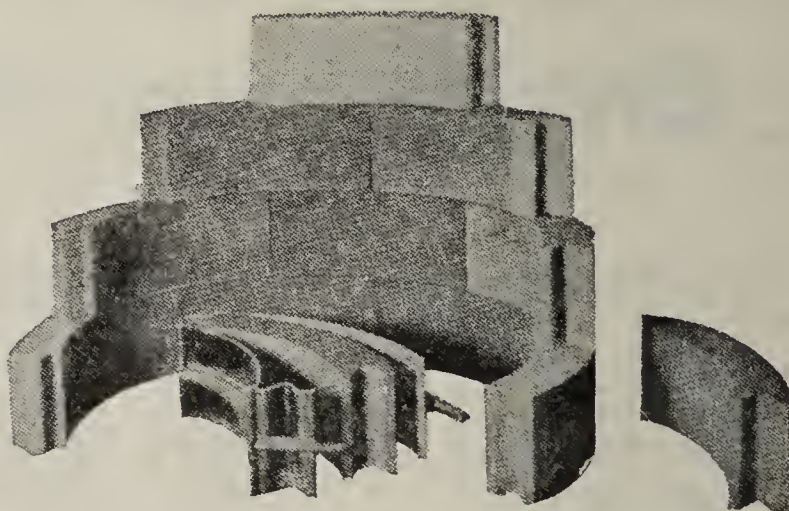
THE PERFECT BRICK MACHINE THE PERFECT CISTERN AND SILO MOLDS

ARE USED IN ALL PARTS OF THE WORLD

OUR MOLDS are the BEST and CHEAPEST ever offered to the public



THE PERFECT is the Simplest, Easiest, Fastest, Most Durable, and is operated with less labor than any other brick machine, therefore yielding more profits to the manufacturer. If you are looking for the latest improved and up-to-date invention you will make no mistake in purchasing the PERFECT.



The Perfect Well, Cistern and Silo Mold.

HERE IS OUR PRICE LIST

No 3 Circle Mold is 3 ft. diam.	No. 10 Circle Mold is 10 ft. diam.
" 5 " " " 5 ft. "	" 12 " " " 12 ft. "
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All sizes up to 7 foot retail at \$12.00 each.

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The Circle Molds vary in length from 22 to 28 inches, depending upon the diameter of its circumference.

In ordering Circle Molds always give the diameter of what you are going to build and I will then understand the kind of a circle mold you desire.

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Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

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Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



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6—Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.

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Fitted for steam or air.

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300,000 ft. 1 1/4 inch

150,000 ft. 1 1/2 inch

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4,000 ft. 12 inches

30,000 ft. 8 in. Cast

Iron

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35,000 ft. 1 1/4 inch

40,000 ft. 3 1/4 inches

60,000 ft. 3 1/4 inches

8,000 ft. 5 1/2 inches

9,000 ft. 6 1/4 inches

1,000 ft. 6 1/2 inches

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The most complete line of Structural Steel and Iron in the city, consisting of I-beams, channels, angles, T's, columns, truss rods, joint anchors, girders, sill plates, sidewalk lights, coal-hole covers, new and relaying rails, bridge work, etc. We cut to any size, punch, rivet and fabricate as far as practical, and deliver all

ready to assemble, at a saving to you of 30 to 60 per cent. Send plan of the work you have in view and let us make you an estimate.

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12—1,000 gallon capacity tanks.

42—1,500 gallon capacity tanks.

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15—3,600 gallon capacity tanks.

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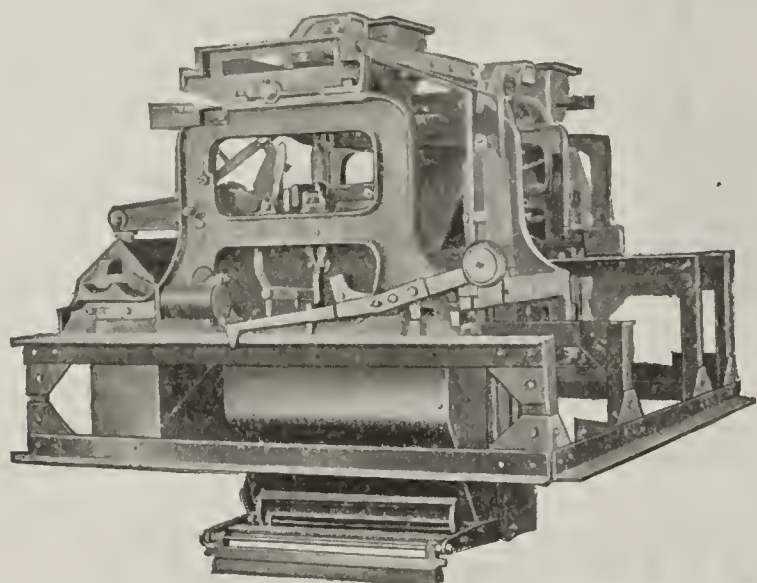
Capacity, 4,500 to 6,500 gallons. These tanks were used only a short time in railroad service. Very heavy construction—1/4" steel with 5-16" heads; domes in proportion to size of tank, and fitted with 15" screwed manhole. We will give them rigid inspection and paint before shipment. Prompt shipment can be made from points South, East and West.

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A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

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TO MAKE THE BEST CEMENT, USE
**Richardson's Automatic
Proportioning Scales**



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

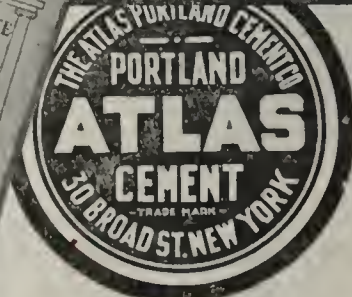
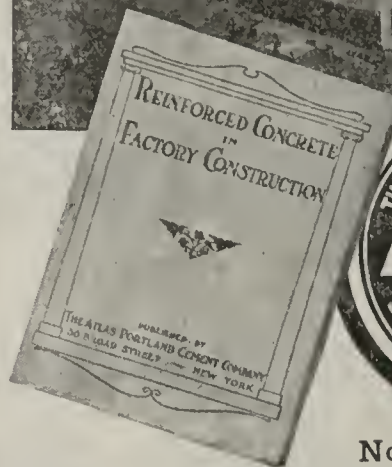
Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

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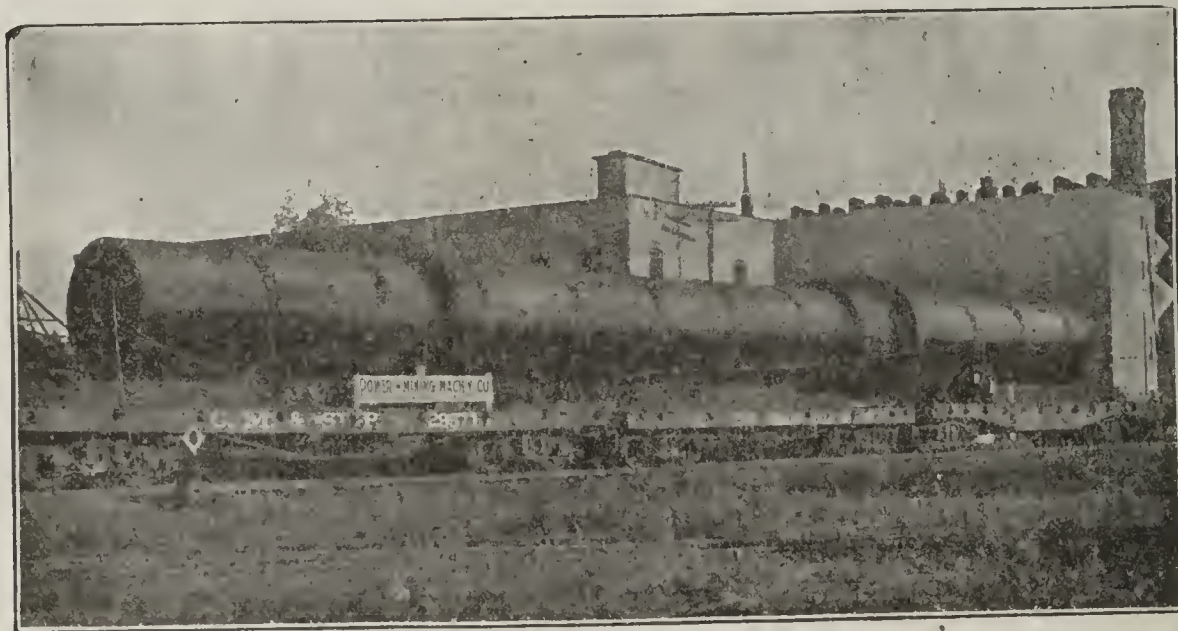
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Largest productive capacity of any cement company in the world. Over 50,000 barrels per day.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



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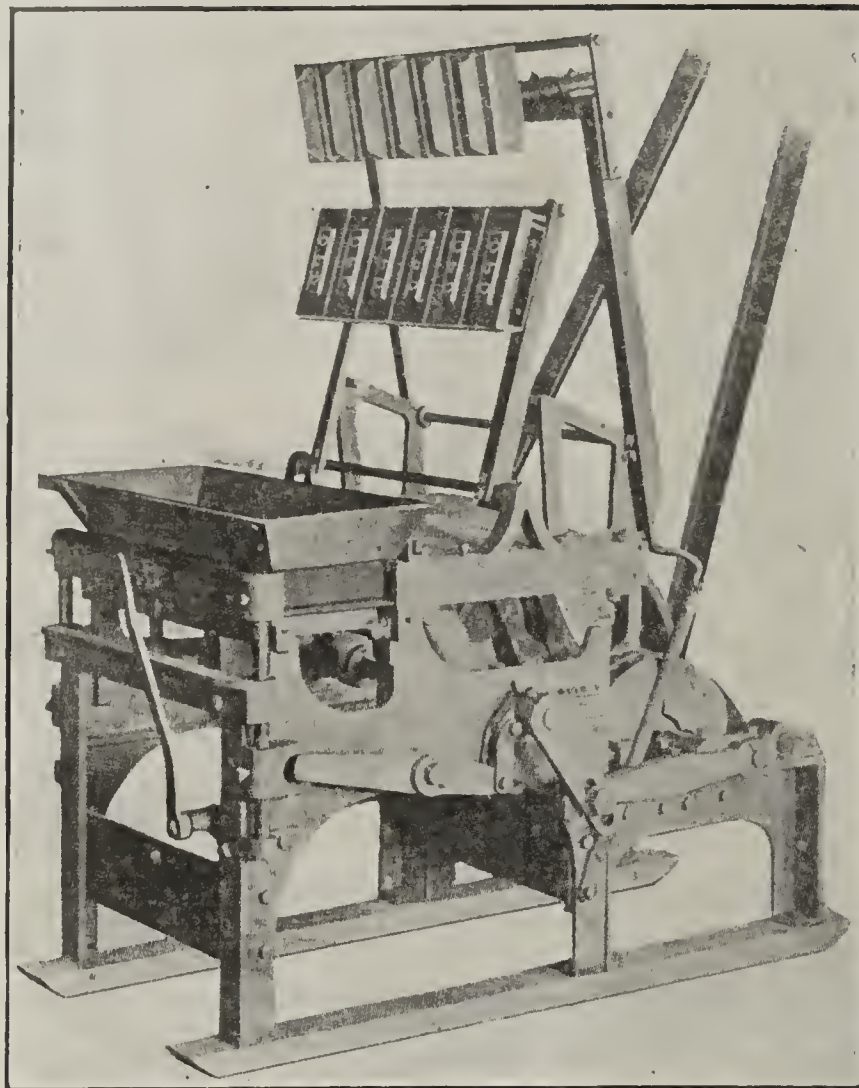
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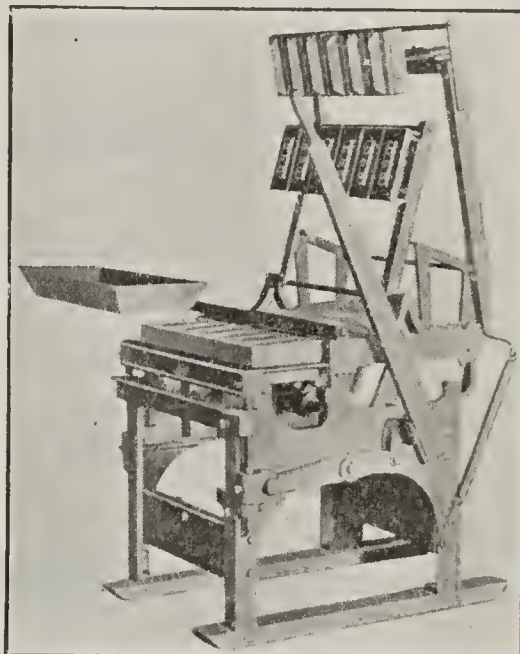
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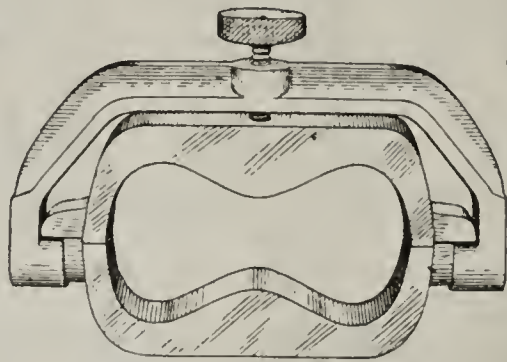
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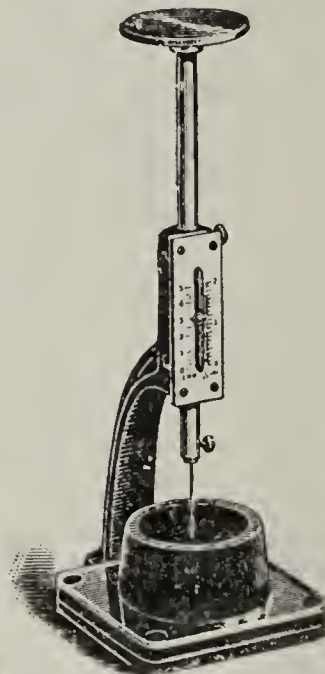
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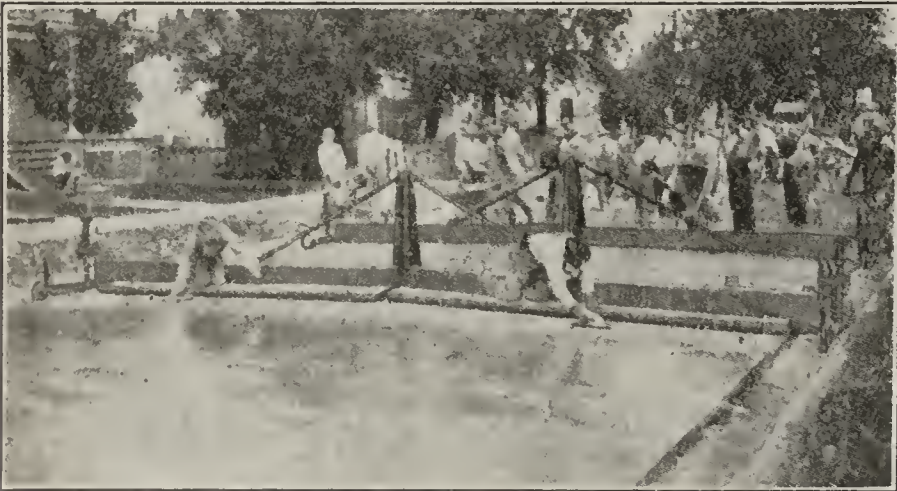
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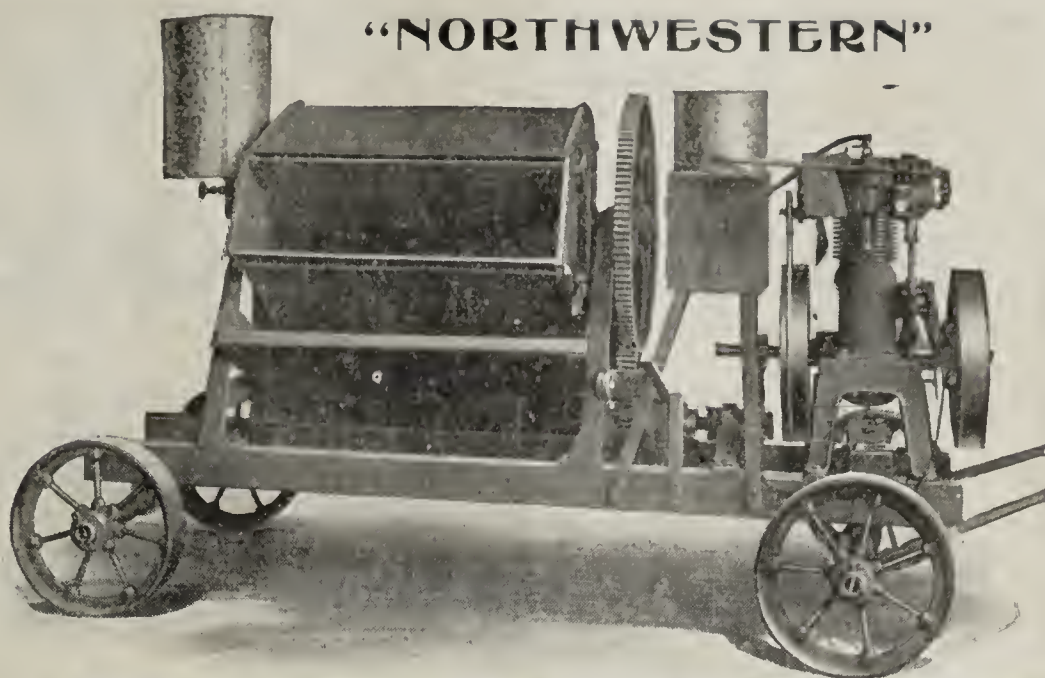
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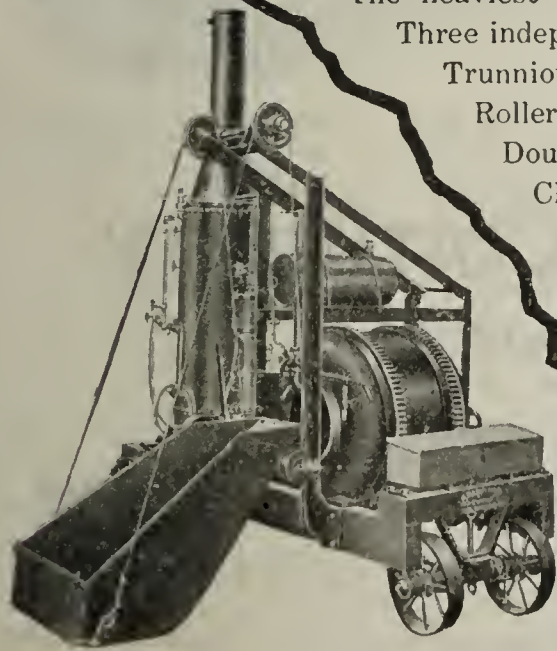
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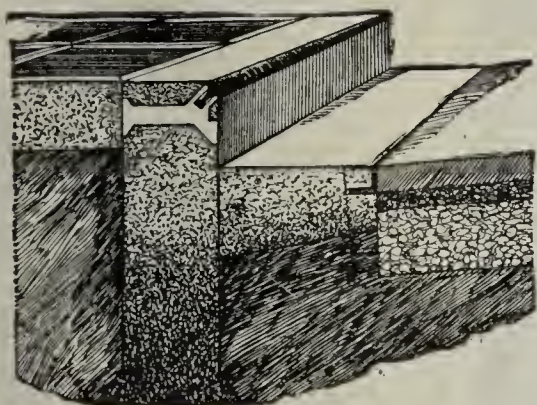
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ENGINEERING NEWS



Mr. I. C. Johnson, while reading a kind letter from the King congratulating him on the 100th anniversary of his birthday.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue
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Advertising Rates Sent on Application.

JOHN F. WALDRON Advertising Manager

Chicago, March 1911.

THE CHICAGO CEMENT SHOW.

The fourth annual Cement Show at Chicago has come and passed without causing the least excitement among exhibitors or visitors. It has now become a familiar event and all business was transacted in an orderly and tranquil manner.

Practically the same exhibitors were present as at former shows and their exhibits did not differ a great deal from those of a year ago. Of course, they were more up-to-date and showed considerable improvement here and there, but, as a whole, the general aspect was about the same, so that the uninitiated may have questioned the necessity of having a similar exhibition every year.

From the exhibitor's standpoint, however, the annual fair must be called a great success. Every year, new students and new advocates of cement construction are won over by the industry, and even, if only a small portion of them visits the exposition and exchanges ideas with the various exhibitors, the gospel of cementology is soon spread all over the country.

The visitor receives new ideas; he learns where mistakes have been made in the past and takes home with him much valuable advice that starts business anew wherever it has grown dull, or becomes the origin of new enterprise in thousands of little towns where the materials can readily be obtained and where people have merely to be educated to the use of concrete.

The annual Cement Show, therefore, represents a course of free lectures, a live illustration forming a valuable supplement to the numerous publications, issued by cement manufacturers and builders of concrete machinery descriptive of the various uses to which cement has been put. From year to year, the application of cement spreads over a wider area, the field of usefulness grows steadily, and in the same ratio its uses develop from merely practical purposes to ornamental and artistic designs of the highest order.

Concrete construction becomes safer owing to the literature issued by competent engineers and associations. In addition to this educational campaign, numerous safety devices contribute towards preventing accidents, especially the modern methods of mixing and depositing concrete and of placing reinforcing steel in a manner that does not permit of its being moved out of place during the pouring of concrete. And at the same time, concrete buildings become more pleasing to the eye and more sanitary on account of the efforts made towards improving the exterior finish and waterproofing concrete work, two facts which can not have escaped the attention of even the most casual observer.

IRON-ORE CEMENT.

The following abstracts from the "Zentralblatt der Bauverwaltung", published by the Department of Public Works, Berlin, Germany, show the progress made in marine construction in Germany.

For the past ten years, the German Government instructed all important engineering departments along the North Sea and Baltic Sea to make comparative tests with Portland Cement and Iron-ore Cement. The results of these tests have been summed up in reports published in 1906 and 1910.

According to these official reports, iron-ore cement has proven to be at least as good as Portland cement in most cases in which it was exposed to sea-water, while the remainder of the tests showed it to be far superior to ordinary Portland cement.

Especially lean concrete mixtures of ordinary Portland cement were found to be insufficient as well as sand-cement mortars made of Portland cement; that is to say all mortars or concrete, to the interior of which the sea-water had access during the comparatively brief time of testing, were seriously affected, if made of ordinary Portland cement, whereas the same sand-cement mortars or concrete mixtures were found to be in excellent condition, if made of iron-ore cement.

As the sea-water will continue to penetrate the concrete and cement mortars, many of the constructions made with Portland cement, or at least the surface layers of them, have to be expected to be completely destroyed after another ten years, while the work done with iron-ore cement will be in the same excellent condition in which it is now.

German Government Engineers, therefore, have rightly come to the conclusion that iron-ore cement, though more expensive than ordinary Portland cement, should be used for all marine work, as costly repairs will be entirely avoided and as, consequently, the construction will prove to be cheaper in the long run.

EXPERIMENTS MADE IN 1902-1905.

(Published Jan. 10, 1906.)

The Governor of Danzig reports, that concrete blocks made of iron-ore cement used in construction work at Hecla and Neufahrwasser do not differ so far from blocks made of ordinary Portland cement (after having been kept in seawater for 3 years), but that cement-sand mortar between granite blocks in the construction of piers proves to be absolutely free of damages, where iron-ore cement was used, whereas the mortar joints show innumerable cracks and are found to be detached from the blocks in all cases in which ordinary Portland cement was used.

Concrete blocks (16-in. cubes) made at Swinemuende with iron-ore cement and ordinary Portland cement in the ratio 1:2:3 and 1:4:6, and exposed to the action of the sea for 3 years, showed no remarkable difference after this period of time so far as their exterior was concerned. The compression strength is given in the following table:

Cube	Cement	Sand	Crushed Stone	Compression Strength in lbs. per sq. in.
1	1 Iron-ore Cement	2	3	5775
2	1 " " "	2	3	5475
3	1 " " "	4	6	3120
4	1 " " "	4	6	2910
5	1 Portland Cement	2	3	4590
6	1 " " "	2	3	5145
7	1 " " "	4	6	2415
8	1 " " "	4	6	3270

Hence, iron-ore cement exceeded ordinary Portland cement in strength about 15 p. c. in the rich mixture and about 6 p. c. in the lean mixture.

The concrete slabs and concrete cubes made of iron-ore cement from Amsterdam and Magdeburg and of iron-ore cement with admixtures of a natural puzzuolana (trass), which were used in 1902, at Munk-Marsch for sea-walls, and on the Island of Sylt in the construction of piers, show excellent behavior so far.

The iron-ore cement supplied by the firm of Fried. Krupp has been made into concrete blocks containing 75 cb. ft. which were used for the protection of piers. It withstood the action of sea-water as well as ordinary Portland cement.

Concrete blocks of 20 cb. ft. contents made of iron-ore cement at Pillau were kept in sea-water for 18 months and then destroyed by ramming. The result was that 30 p.c. more power was required to destroy the blocks than in the case of blocks of equal size and composition made of ordinary Portland cement.

Experiments made in Emden since 1902 with concrete blocks made of iron-ore cement as well as those started at the same time at Borkum have given entirely satisfactory results so far. On the whole, the tests made with iron-ore cement up to this time are very promising.

EXPERIMENTS MADE IN 1905-1908.

(Published Nov. 20, 1910.)

The comparative tests, described in January 1906, with concrete and mortars made of iron-ore cement and of ordinary Portland cement have been continued.

In the marine constructions at Memel, all experimental tests accompanying the construction work showed for iron-ore cement at least the same behavior as ordinary Portland cement. Similar results were obtained at Stolpmuende, where 1 cement : 3 sand mortars were used for marine work as well as blocks of 100 cb. ft. in the proportion of 1 cement, 4 sand, 6 crushed stone.

According to further reports from the Governor of Danzig, iron-ore cement mortars continued to be far superior to ordinary Portland cement in all instances, in which the mortar formed the joints between granite blocks.

The concrete slabs made of iron-ore cement at Munk-Marsch and exposed to the sea since 1902 were found to be in excellent condition.

Also all work done at Emden and Borkum with iron-ore cement and iron-ore cement with admixtures of trass proved to be satisfactory in every respect.

A dam constructed at Norden of concrete blocks of the composition 1 cement, 3 sand, 5 gravel showed deep cracks wherever ordinary Portland cement was used so that gradual decaying of the blocks has to be expected. In opposition hereto, all parts of the dam where iron-ore cement was used are in perfect condition. It has been decided, therefore, to use exclusively iron-ore cement in the future. The fact that iron-ore cement is more expensive than ordinary Portland cement does not prove to be a disadvantage, as iron-ore cement can be used as mortar with 4 parts of sand, whereas ordinary Portland cement can only be used in very rich mixtures.

Comparative tests seem to indicate that Portland cement obtains its highest strength in soft water, while iron-ore cement excels it in sea-water.

THE STERRIT-THOMAS FOUNDRY CO.

The Sterrit-Thomas Foundry Co. of Pittsburgh, Pa. have just issued an illustrated catalogue descriptive of cement machinery manufactured by them.

Their specialities are Rock Crushers, Grinding Machinery, Rotary Dryers, Rotary Kilns and Valves.

CONSEQUENCES OF THE USE OF MORTAR OF WRONG COMPOSITION.

By M. M. Van der Kloes.

The subject of properly proportioning the ingredients used in the manufacture of mortars belongs to those chapters of the building trade which, unfortunately, are not fully understood by most architects and contractors. The losses due to ignorance in this matter of prime importance are enormous.

Three points have to be fulfilled, if the mortar shall be strong and durable:

1. The mortar must possess a certain degree of hydraulicity, that is to say, it must be a water-resisting mortar.
2. It must contain sufficient sand.
3. The amount of lime must be limited as much as possible.

In my opinion, it is impossible to obtain a reliable piece of masonry by using simply slaked lime and sand as mortar. Wherever brick work of superior durability and strength is obtained, the mortar may be depended upon to possess more or less hydraulic properties.

The two last-named points are somewhat related; however, they do not cover entirely the same idea. Without a sufficient amount of sand the mortar contracts and ceases to adhere to the stone.

Another cause of the destruction of brickwork, and one which proves to be more fatal, is the faulty proportioning of lime and puzzuolana in lime-puzzuolana mortars.

With regard to the sand, mistakes are most frequent in the Netherlands and in Belgium, where specifications even of the building departments of the largest towns prescribe in some instances mixtures of lime and puzzuolana without sand. This is an old custom in these countries, to be sure; yet in former times the disadvantages accompanying it were not as noticeable, because an imperfectly calcined lime, originating from shells, was used in connection with coarsely ground puzzuolana. Both of these ingredients, therefore, contained a certain quantity of grit which acted the part of sand in the mortar. But nowadays puzzuolana is put upon the market, and is demanded to be as fine as flour and shell-lime is burnt more perfectly. In spite of this, however, builders still adhere to the old custom, even if they make use of the richest Belgian limes.

If a similar lime-puzzuolana mixture without sand is used for work that is constantly covered by water, the disadvantage amounts merely to a great loss of money; but, if exposed to the air, contraction causes it to separate from the stone or brick at a number of places. As a consequence, the binding mortar crumbles to pieces and the outer layers of a wall go gradually to destruction. Similar phenomena are generally attributed to freezing weather and, for this reason, many people even believe that lime-puzzuolana mortars can not resist frost.

As for the proper proportions of hydrated lime and puzzuolana, it is evident that the unison of these two materials, which results in a homogeneous body, requires a well-defined proportion, which assures best results, and that a small deviation from it, in one direction or the other, must be harmful.

In the case of mixtures of puzzuolana and lime, the highest degree of perfection is attained, if each particle of puzzuolana is completely surrounded by lime-paste, so that its surface is acted upon by the lime and cemented together with the particles adjoining it. A surplus of puzzuolana remains unaffected; it takes the part of so much inert material or sand and causes no trouble whatever. But, on the contrary, a surplus of lime gives rise to all kinds of troubles which manifest

themselves daily. The fine particles of puzzuolana disappear, so to speak, in the lime-paste. A solid body is likewise formed, however one that absorbs water very readily, that is washed out by it and gives birth to scaling off and corroding of the wall.

If masonry of this kind is submerged in water from time to time, it goes to destruction even more rapidly. This explains the common occurrence of piers corroding at the water level, which is still hastened where strong currents prevail or where the waves dash against them. I found remnants of a lime-puzzuolana mortar without sand in the masonry of a water-mill, which were so completely washed out and broken up that they could be disintegrated by the slightest pressure.

About thirty years ago Schalkwijk and Penning of Rotterdam demonstrated that a mixture of 40 parts by weight of dry slaked high grade lime and 100 parts by weight of puzzuolana (which equals 1 part by volume of lime to $1\frac{1}{4}$ part by volume of puzzuolana) yields superior results to any other mixture containing more lime, and that the strength of nine mixtures contain-

	Volume of Puzzuolana- Cement:		Volume of Sand:
Mortar No. VI:	1	plus	1
Mortar No. XII:	1	"	$1\frac{1}{2}$
Mortar No. XVIII:	1	"	2
Mortar No. XVIII:	1	"	3

ing from 40 parts by weight to 140 parts by weight of hydrated lime to 100 parts by weight of puzzuolana decreased steadily, so that the mixture highest in lime showed only 25 per cent of the strength of that containing the smallest percentage of lime.

As a surplus of puzzuolana is required in every instance, in order to obviate washing out, scaling and corroding, I advocate for high grade dry slaked lime a mixture of $1:1\frac{1}{2}$ by volume, (that is to say, 1 part by volume of hydrated lime to $1\frac{1}{2}$ part by volume of puzzuolana, which equals 1 part by weight of hydrated lime to 3 parts by weight of puzzuolana) and for less pure limes, as for instance shell-lime, a mixture of $1:1\frac{1}{4}$ (that is to say, 1 part by volume of hydrated lime to $1\frac{1}{4}$ part by volume of puzzuolana, which equals 1 part by weight of hydrated lime to $2\frac{1}{2}$ parts by weight of puzzuolana). The puzzuolana referred to throughout this article is 'trass' from the Eiffel region in Germany, a natural puzzuolana, that is extensively used all over the northern part of Europe.

By the foregoing I wish to have emphasized that the lime puzzuolana mixtures adopted by me are not inferior in strength to those used by others. However, the determination of their resistance to tensile strain and crushing stress alone is absolutely insufficient for the valuation of the mortar for practical purposes. Mortars of high resistance, but of faulty composition, are apt to cause scaling and corroding, and even impervious mortars are liable to gradual washing out and softening by water.

Concerning the application of lime-paste, I wish to say that I usually consider one measure of lime-paste to be equivalent to two measures of hydrated lime in powder form. This follows from the following deliberation: If one liter of high grade Belgian slaked lime-powder (weighing 500 grams) is mixed with 250 grams of water, half a liter of a stiff lime-paste is obtained. This proportion may differ slightly with other grades of lime and be as low as $1:1\frac{1}{2}$ in the case of freshly slaked lime. Therefore, it is advisable to measure the lime in powder form, or even better to weigh it, whenever a high degree of accuracy is demanded.

Impervious is every hydraulic mortar, in which the cement fills completely all voids between the sand grains. Hence, it is easy to determine in advance whether or not a mortar will be impervious, by preliminary measuring of the interstices of the sand and broken stone. However, it would lead too far to go into details in this matter.

The question then arises: To what degree does puzzuolana take the place of cement in this calculation? This depends entirely upon its fineness and upon the more or less complete mixing with lime. The whole of it is to be considered only, if puzzuolana and hydrated lime are ground together to great fineness and thus form the "puzzuolana cement." This method is to be recommended in every instance.

It is surprising what large amounts of sand can safely be mixed with these puzzuolana cements, if the proportions of lime and puzzuolana are given separately.

For instance, the puzzuolana cement of the following table represents a mixture of 4 parts by volume of slaked shell-lime and 5 parts by volume of puzzuo-

	Volume of Hydrated Lime:		Volume of Puzzuolana:		Volume of Sand:
equality	1	plus	$1\frac{1}{4}$	plus	$2\frac{1}{4}$
"	1	"	$1\frac{1}{4}$	"	$3\frac{3}{8}$
"	1	"	$1\frac{1}{4}$	"	$4\frac{1}{2}$
"	1	"	$1\frac{1}{4}$	"	$6\frac{3}{4}$

lana, which are ground together (or 1 part by weight of lime to $2\frac{1}{2}$ parts by weight of puzzuolana).

The mortar 1:3 is very suitable for masonry work, while that of the proportions of 1:2 is used for plastering.

If Portland cement mortar is expected to be absolutely impervious, it must not contain more than two parts by volume of sand to 1 part by volume of cement. Brick work made with this mortar shrinks on account of the contraction of the mortar in the air. Therefore, at least $2\frac{1}{2}$ parts by volume of sand should be used for each volume of Portland cement, and it is even safer to use a mortar composed of 3 parts of sand to 1 part of cement.

Portland cement mortar in the proportions of 3 parts of sand to 1 of cement is still rather expensive. However, the addition of more than 3 parts of sand renders the mortar hard to work with. For this latter reason, and also in order to decrease the expense, Portland cement mortar is mostly diluted with lime-paste, a practice which is utterly objectionable, because it leads to the formation of scales and to gradual corrosion of the masonry.

These defects are so common nowadays in masonry of any description that it is astonishing to see even well-known architects still follow this practice.

The surplus of lime manifests itself in a two-fold manner: In the first place, it gives rise to a gradual process of corrosion and crumbling to pieces of the masonry, which starts on the surface and works its way into the interior; and in the second place it produces peeling of the surface in thin layers, which are sometimes hard and quite large in size. This is caused by the expansion of lime-salts that accumulate in the pores immediately under the surface. If similar scales are placed, upside down, and moderately heated, a white deposit becomes visible after some time; however, if quickly heated, it cannot form, because the water evaporates before it reaches the surface.

About the causes of the corrosion of masonry very little is known so far. Most likely they are traceable to the fact that the crystallization of the lime-salts in the pores of the stone or brick is accompanied by an

increase in volume which destroys the adjacent particles. These salts alternately dissolve and crystallize in rainy and dry weather; the same particles of salt, therefore, are able to carry on their work of destruction repeatedly.

From practical observations I learned that these phenomena are more pronounced, if the mortar is gauged with sea water than in the case of fresh water, and, in fact, in some parts of Northern Holland mortars are often mixed with brine. The destruction can be noticed in the case of burnt clay brick as well as at argillaceous sandstones and especially at trachyte. As far as I remember, I never noticed it in natural limestones and only very seldom at sand-lime brick.

Cement-lime mortar must likewise be injurious to enamelled brick and to all kinds of tiles. The enamel contains innumerable little cracks in which the salts start their work of destruction in the same way as in the joints of the binding mortar between the tiles. In time crystallization develops under the enamel and the latter breaks off. This can be observed very frequently at underground tunnels.

In my mind, there is no doubt that most of these cases in which masonry is thus destroyed are not attributable to the brick or stone, but to the binding mortar. A short stroll over the scaffolds of the Cathedral of Cologne further strengthened my opinion. During the brief time I spent there, I may have been unable to properly recognize and identify each building stone or mortar; however, it is an undisputed fact that certain kinds of limestone are not subject to destruction in the manner indicated.

It is difficult to share the general opinion on this subject to the effect that the sulphuric acid contained in the atmosphere be responsible for the corrosion.

Wherever lime-puzzuolana mortars are used according to my prescriptions, which have been widely adopted by practical men, the defects in question never become noticeable. The same is true of mortars made with Portland cement to which puzzuolana, instead of hydrated lime, is added. Moreover, the admixture of puzzuolana renders the Portland cement safe against the injurious action of the sea water. In the Netherlands, a mortar composed of 1 part of Portland cement, 1 of puzzuolana and 4 of sand has been used with great success in important marine constructions, and cisterns can safely be built of a mortar of 1 Portland cement, 1 puzzuolana and 3 sand.

Puzzuolana and Portland cement supplement each other admirably; it is, therefore, unwise to regard them as antagonists.

Also in combination with Portland cement, the best results are obtained, if puzzuolana and cement are ground together. In reality, there is no objection to the honest sale of a mixture of equal parts of Portland cement and puzzuolana; indeed, all parties concerned would profit by it, especially because some Portland cements gain in strength up to 10% by similar admixtures.

Of course, it is not surprising to see the Portland cement manufacturer defend his product and to sanction the common application of cement-lime-mortars to which I object. One of them denies even the lack of adhesion of rich cement mortars and contradicts my statement that cement-lime-mortars are the cause of scaling off and corroding of masonry. According to him, nothing but "beauty defects" could result from their application. He cites numerous buildings in which cement-lime mortars have been used successfully. However, the laws of nature are the same all over the world and I am convinced that, on a visit to the works in question together with my opponent, I should be able to point out to him in every instance not only beauty defects, but far more serious blemishes.

Moreover, a reliable mortar does not even produce beauty defects. If it does, it is not a reliable mortar, for it is evident that these beauty defects are merely the first signs of future destruction, and generally they are accompanied by more fatal indications of beginning corrosion. A dam or pier, for instance, must be free from crevices in the mortar joints at all times, and if a puzzuolana mortar, that was impervious in the beginning, is washed out in time, it contains too much lime.

The lean mortar mixtures of my table are especially disliked by the bricklayer. It happened that they refused to make use of a mortar that contained a large proportion of puzzuolana and, because it did not work as easily under the trowel and made them tired; consequently they stopped working. Tiring of work, of course, is the most unpleasant thing that can happen to a bricklayer. However, on account of lack of work they came back, supplied with strong leather bracelets around their wrists.

A number of conglomerate walls of ruins plainly show how long lean mortars keep in the air. Especially in this kind of masonry the mortar must be very lean, as otherwise the mortar joints shrink away from the stone, which we observe often in the case of basalt walls in our modern times.

A piece of masonry must certainly be very solid, if it breaks, following an explosion, into a few single pieces of gigantic proportions, as the tower of the castle of Heidelberg did.

At Lindenfels, Odenwald, I found an example of similar old masonry and at the same time a proof of the obstinacy of our present day's masons. At the foot of the ruins of the old castle, walls of terraces could be seen, laid in cement-lime mortar, at which, on account of the contraction of the mortar, not one stone firmly adhered to the other. A mason was occupied with the construction of a wall, for which he likewise used cement-lime mortar, without paying attention to the poor result obtained with this mortar mixture before and without learning a lesson from the splendid castle walls above him.

However, not the bricklayer alone is to be blamed for the daily mistakes he makes along these lines; I know engineers of great reputation and learning, in charge of railroad constructions, who prefer cement-lime mortars, although the masonry constructed under their supervision offers a lamentable spectacle. The buildings begin to corrode before they are even finished.

And what to say of the builders of churches! If a person notices how most churches constructed during the past 25 or 30 years are fast corroding and how, in spite of it, architects still use cement-lime mortar in the construction of new churches, he naturally asks himself, whether the germ of decay is put in these buildings on purpose in order to illustrate the evanescence of everything on earth.

That the Netherlands is not without a parallel in this respect, I learned from Professor Nagy, who informed me that at several new churches in Budapest the effects of corrosion were so plainly visible, that, jestingly, he advised the architects, who would not abandon the practice of using cement-lime mortars, to cover the stone parts of the buildings with zinc plates which would protect the mortar against being washed out by rain.

A Berlin architect wrote me that I could make the same observation in several instances in his city. During a visit to Berlin, therefore, I did not fail to go and see these buildings and, in addition, I found many more. Among others I examined Grace Church, in the Invalid's Park, which was built of the same volcanic rock as the church at Weibem in the Eiffel and which sowed scaling off of the surface to a high de-

gree. This naturally astonished me, as this stone was known to be one of the most weather-resisting, and as the church in the Eiffel mountains, which was built of the same stone during the years 1110-1156, still had an absolutely new appearance.

This evil is so widespread in Germany that similar phenomena of corrosion can be observed at a great number of places. The tunnels of the railroad stations at Cologne and Koenigswinter, which are lined with enameled tile, are continuously scaling off. There is no remedy for it. The viaduct along the Rhine at Linz looks horrible. At a number of places the destroyed brick have been replaced.

Some men of the profession attribute the cracking off of the enamel of tiles to frost. However, at Delft I can easily point out to them new walls that went to destruction in the course of a few months, before frost ever had any effect upon them.

Among the numerous cases of formation of scales and corroding of masonry that I observed in the Netherlands and that were due to the application of cement-lime mortar, two deserve special mention. One was the front of a brick building in the old Dutch style at Leyden that had resisted the influence of the weather for centuries. It had to be torn down and was re-erected at Delft in 1875 as an example of mediaeval national architecture, and in accordance with the custom of the time cement-lime mortar was used. At present, after the lapse of a few decades, the consequences are plainly visible. The front of the building is corroded at many places; the surface of several brick is destroyed an inch deep.

The other case was a chimney of a factory at Oudenbosch, which I found in such a ruinous state in 1905, three years after its erection, that it had to be torn down several months later. The mortar used for it was composed of approximately 1 part of Portland cement, 2 or more parts of lime and 3 parts or less of sand. The perforated brick used were not equal in hardness, but were fairly good. The compression strength could be tested easily at brick taken from the base of the chimney; it amounted to from 900 lbs. to 3300 lbs. per square inch, while the actual pressure which the lower part of the chimney had to withstand was only about 60 lbs. per square inch. The partly inferior quality of the brick was only an accessory inasmuch as the influence of mortars of wrong composition is greater on porous brick than on well-burnt brick. The high temperature, moreover, assisted the process of crystallization to such an extent that the brick burst.

Lime-puzzuolana mortars containing too much lime are just as bad as cement-lime mortars. As the former are longer in use than the latter, we are able to study their behavior over a greater period of time.

Among the oldest buildings of this kind that I had an opportunity to inspect were the fortifications around Utrecht, built in the beginning of the last century. Seen from a distance, the mortar seems to run down the wall in a continuous white stream. Closer examination, however, reveals the fact that most of the brick lie one on another without cohesion whatever and that the lime-puzzuolana mortar, which was too rich in lime and contained but little sand, had attacked and corroded them to such an extent that they had scaled off in a horizontal direction.

At the same place, several piers were torn off during the past years, which dated from the middle of the last century. At all of them, there was no cohesion between the brick and mortar. In spite of this, harbor works could be seen in the course of construction for which a mortar of 1 cement, 2 sand was used!

The inspection of a masonry viaduct at Arnhem

was of special interest. It dated from the middle of the past century and was torn down in 1909. This construction, although moist throughout and partly washed out by water, was still quite solid. Only the upper layers, which had to suffer the most from the water, were without cohesion. In the interior, however, numerous veins of water became visible and, here and there, layers of stalactites that had formed evidently during dry seasons.

Equally obvious are the consequences of the faulty composition of lime-puzzuolana mortars used in the

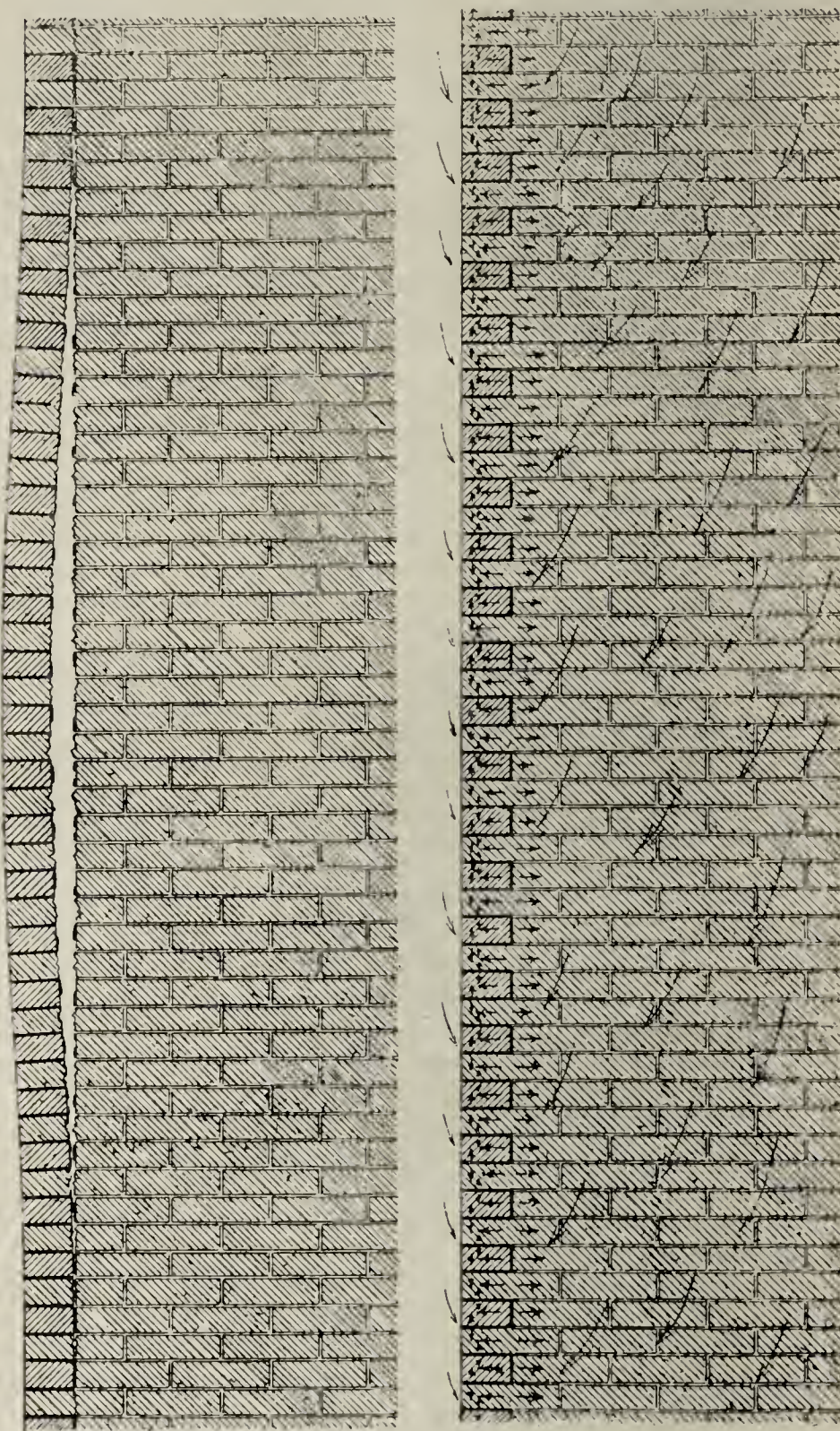


FIG. 1.

FIG. 2.

construction of several piers and walls of railroad bridges in the Netherlands. I inspected six of them very closely that had been built about 25 or 30 years ago. In every instance the masonry was found to be in a state of deterioration which could not be halted by any repairs. The mortar that composed these bridges consisted above the water-line of 2 parts of powdered slaked lime, 1 part of puzzuolana without sand and below the water-line of 2-1/2 parts of lime, 1 of puzzuolana and from 1 to 1-1/2 parts of sand. Wherever Portland cement was used, it was composed of 1 part of cement to 2 parts of sand.

However, the application of a surplus of lime and the lack of sand or total absence of it were not the only errors in these constructions. As they were built of cut stone, a third mistake was made in leaving the

wedges, needed in mounting them, in place. As a consequence, most blocks were split in two or three pieces, after the mortar had separated from the stone and had been carried off by the current. Several stones crumbled to pieces at the places where the wedges were located.

Where brickwork instead of cut stone is used, the outside layers of the masonry, which always suffer the first and the most from the contraction of the mortar, have likewise separated and extensive repairs were the consequence of it. In an advanced stage, the lack of cohesion of the masonry can be recognized by the dull sound, if struck with a hammer.

Sometimes a strange phenomenon can be observed, namely the buckling of a wall caused by the splitting off of the outside of the masonry, half a brick thick (see figure 1.). This finds its explanation in the following: In a completely water-saturated wall the water follows the line of least resistance, which leads to the surface. Moreover, the outside is always the wettest part of the wall on account of the rain (represented by the curved arrows in Fig. 2.) The mortar joints on the outside of the wall and those immediately behind the outside course of brick (represented by heavy black lines) are, except in dry seasons, completely saturated with water and expand in freezing weather.

Prescriptions for the Composition of Pozzuolana-Mortars and Portland-Cement Mortars.

No.	Shell-Lime	Fat-Lime	Lime-Paste Dry	Water	Pozzuolana	Portland-Cement	Pozzuolana plus Hydrated Lime	Sand
A. Mortars that are absolutely impervious and are always to remain under water.								
I	1	—	—	—	1,25	—	—	1,50
II	—	1	—	—	1,50	—	—	2
IIIa	—	—	1	—	3	—	—	4
IIIb	—	—	—	1	2,25	—	—	3
IV	—	—	—	—	—	1	—	2
V	—	—	—	—	1	1	—	2,50
VI	—	—	—	—	—	—	1	1
B. Mortars to be used for Quay-Walls, Locks, etc.								
VII	1	—	—	—	1,25	—	—	2 to 2,50
VIII	—	1	—	—	1,50	—	—	2,50 to 3
IXa	—	—	1	—	3	—	—	5 to 6
IXb	—	—	—	1	2,25	—	—	3,75 to 4,50
X	—	—	—	—	—	1	—	3
XI	—	—	—	—	1	1	—	4
XII	—	—	—	—	—	—	1	1,50
C. Mortars to be used for Foundations and Walls.								
XIII	1	—	—	—	1,25	—	—	3 to 4
XIV	—	1	—	—	1,50	—	—	4 to 5
XVa	—	—	1	—	3	—	—	8 to 10
XVb	—	—	—	1	2,25	—	—	6 to 7,50
XVI	—	—	—	—	—	1	—	3
XVII	—	—	—	—	1	1	—	4 to 5
XVIII	—	—	—	—	—	—	1	2 to 3

As a consequence, horizontal and vertical stresses are set up (represented by straight arrows in Fig. 2.) The horizontal stresses burst the joints behind the outside layer of brick and the same expansive force exerts sufficient tensile strain upon the transverse course of brick to break them. The vertical stresses being counteracted from above by the weight of the masonry and of the iron structure on top of it and from below by the ground, the course of brick, thus split off, buckles.

At many places on the surface of brickwork or stone masonry of pillars of bridges, little rivulets can be seen to come out of the walls. Here and there, they are found to be temporarily dried out and, in this

event, have left crusts, the color of which enables the observer to tell whether lime-pozzuolana mortar or cement-lime mortar was used. Sometimes cones of stalactites can be seen under the cornices.

These and a great number of other examples of rapid destruction of masonry which I described from time to time have opened the eyes of many architects and engineers, who henceforth are willing to follow my advice. The remainder, who are still ignorant of the cause of the corrosion and those who are too self-conceited will be cured in time by additional failures.

MODERN PLANT OF THE ATLANTIC AND GULF PORTLAND CEMENT COMPANY.

The fast growing little city of Ragland, Ala., can at least boast of having in full operation the largest Portland cement producing plant in the South.

Lying about three-quarters of a mile southeast of the city, there are nearly 5,000 acres of land belonging to the Atlantic and Gulf Portland Cement Company. This land extends from the city limits to the Coosa river, and is covered with a dense growth of timber, which is worth many thousands of dollars to the cement company. Beneath the surface is to be found all of the raw materials necessary for the manufacture of the highest grade of Portland cement. Along the Coosa river, rising in bluffs 300 feet high, are ridges of high-grade limestone, and the supply is inexhaustible for generations to come. Within a stone's throw of the mill are hills of shale and clay, which are important raw materials. The chemical composition of this shale is remarkably uniform, and the proximity of the deposits to the mill enables the company to mine and deliver this material at the least possible expense.

At several points on the company's property are outcrops of high grade bituminous coal, showing veins up to four feet in thickness. There are seven of these veins of workable thickness, and the coal is of an excellent quality for the purpose intended—that is, cement burning—and, furthermore, it is so soft that but little grinding is necessary to reduce it to powder form, to which degree of fineness it must be ground. Should the company at any time desire to ship the surplus coal mined and not needed for their own use, the railroad is only a stone's throw away from the place where the opening of the seams are. Geologically the formation is absolutely regular and several miles distant from any fault. It has been estimated by geological experts that the three and four-foot seams alone will supply over 30,000,000 tons of coal.

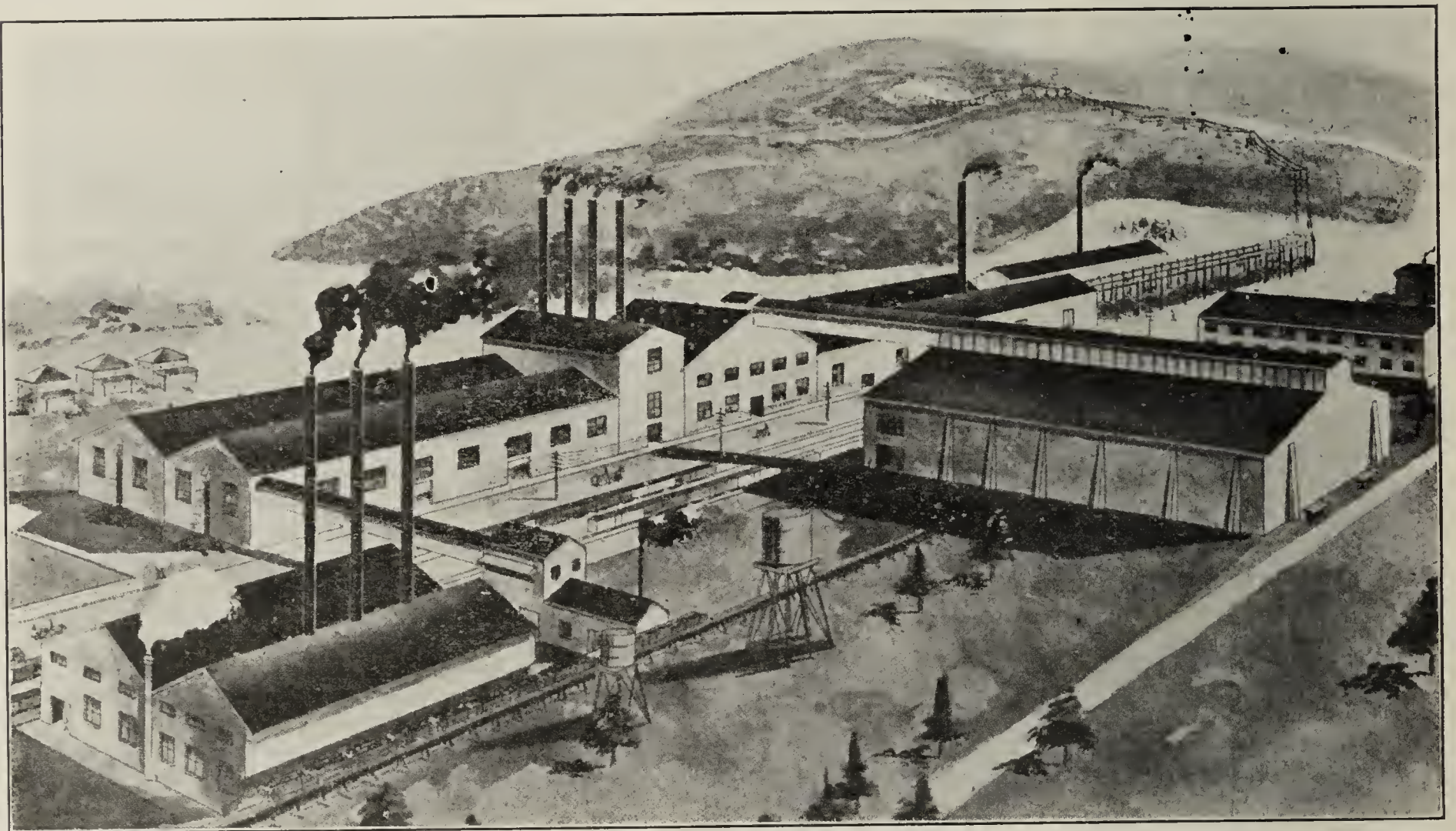
The mill is of modern design and equipment, and its cost was over \$1,000,000. The buildings cover a large area, and yet are so well planned that the material moves from one end of the mill to the other through the various processes. All of the buildings are of steel and concrete construction, and are absolutely fireproof throughout. Running through the center of the mill are spurs from the Seaboard Air Line railway, from which raw material can be unloaded and on which is loaded the finished product. There is about five miles of trackage on the company's property.

As the writer has recently had the opportunity to make a thorough trip of inspection through the mill and has had explained to him the many steps of the various processes, it will be of interest to our readers for him to tell in his own words what he saw. In order that he might see the process from start to finish, he was driven to the quarry, which is but a stone's

throw from the Coosa river yet is separated therefrom by a lofty ridge of solid limestone. Here the cement company is wresting from nature in a most forcible way the treasures which have been stored up for untold ages. Overcapping the rock there was a small covering of clay and chert. Before any rock was quarried this material, which was of no value in cement manufacture, was washed away by means of powerful streams of water into the creek, which winds around the base of the quarry. Thus the rock was stripped of undesirable material, and there then remained a naked expanse of limestone stretching up the hill for 250 feet.

Powerful steam drills were then called upon to bore the holes, into which was to be placed the charges of dynamite. These holes are drilled up to 18 feet deep and in a row along the face of the quarry and at different levels. When one row of holes has been drilled they are filled with a charge of dynamite, and at the

taut by means of huge boxes filled with stone, which are suspended to the ends. Because of the long distance, it is necessary to have a tension station midway of the distance, where other boxes add their weight and impart to the cables such a rigidity that they could well be spoken of as tracks, for such is their purpose. Besides the cables, there runs an endless wire rope, which passes over large sheave wheels at each terminal station where this driving rope makes the turn. It is to this rope that the buckets are attached, and by means of it they are conveyed over the cable tracks. The buckets, which we saw loaded at the quarry, are pushed to the loading station, when they are met by bales suspended from the cable and running thereon by means of two small wheels. As the bales come around they are fastened automatically to the buckets and then move to the end of the cable, where again automatically they are gripped by the driving cable. This driving cable runs at a speed of 550 feet a minute,



Works of Atlantic & Gulf Portland Cement Company, Ragland Ala., Clarence N. Wiley, B.Sc., Chief Chemist. The Bleichert System of Aerial Tramways is shown in the background, furnished by Trenton Iron Co., Trenton, N. J.

pressure of a button by an operator, who remains at a safe distance, there is thrown with a roar like that of Niagara many hundreds of tons of broken stone. Small portable tracks are then laid down, and over these tracks are pushed cars with ball-bearing wheels, on each of which there are two buckets holding each 1,200 pounds of rock. Four men are assigned to each track, and these men load up the buckets. Converging through switches to a single track, these cars are pushed up to the loading station of the Bleichert aerial tramway.

This tramway is one of the most spectacular, as well as important, features of the system. It was installed by the Trenton Iron Works of Trenton, N. J. Two interlocking strand steel cables, one twice as large as the other, stretch away over hill and valley to the mill, which is over 8,000 feet away. These cables are supported at short intervals by towers which vary in height from 6 feet to 44 feet. These cables are kept

and the buckets are placed at intervals of 250 feet.

The writer was invited to make the return trip to the mill in one of these buckets. With some hesitancy he accepted the honor after he was assured that the trip would be a perfectly safe one and a most interesting experience. Stepping into a bucket, which was large enough for him to sit down in, the word was given and a slight jerk informed him that the driving rope had been caught. Before him at short intervals as far as he could see were buckets loaded with stone moving along in stately procession, and behind him came the buckets carrying the accompanying officials of the company. The sensation was much like flying, with the additional assurance that he could not be dashed to the ground. Now coming within a few feet of the ground, where the cable crossed the top of a hill, the ground began to slope away, and in a few minutes upon looking from the car the writer saw that he was traveling along in midair fully 100 feet from

terra firma. At several other points this experience was repeated, and but a few minutes passed before he came within sight of the mill. Here the buckets entered the unloading station, where the cable gave way to a track, which stretched over a trestle to the crusher. The bales were automatically detached from the driving rope, and a man in waiting pushed the bucket along the short distance. Here the passengers disembarked and allowed the buckets to make the return trip empty.

Yawning before us was the mouth of the giant crusher. This is a No. 7½ Gates Gyratory crusher, and into its maw is dumped all of the rock which is brought over the tramway. This crusher is run by a 60-horse power electric motor, and the rock is reduced from pieces a foot square to fragments, the largest of which will pass a two-inch ring. Dropping into a bucket elevator the crushed rock is raised to the second floor, where it is dumped into a large bin over the scales.

Off to one side of the crusher building is the shale building, and 300 feet east of this is a hall of shale, where at present there is a face 45 feet high and 150 feet wide. The shale is brought to the storage shed by means of an incline, on which cars of loaded material are carried up by a cable attached to a drum, and the empty cars run back by gravity. Arriving at the storage shed, the shale is dumped on a large pile, under which runs a belt conveyor, which carries the shale from any part of the pile to a Webster disintegrator. This is a machine which breaks up the large lumps and drops the material into a bucket elevator which feeds the dryer.

This dryer is of the rotary type, and is 60 feet long by 6 feet in diameter. The inside is equipped with shelves and Z-shaped bars, which toss the material about when the dryer is in operation. From a fire-box at one end the hot gases pass up through the dryer and meet the shale coming in the opposite direction. This dryer will dispel all of the water in a shale containing as high as 25 per cent. moisture. From the dryer the shale is elevated to a bin over the scales, which bin is placed beside the crushed stone bin hereinbefore mentioned.

The scales are of the Richardson Automatic type, and are, as an official remarked, "fool-proof." The outfit consists of two separate scales, one for the stone and the other for shale. Feeding through chutes from the bins each material drops into its respective scale hopper, which is nicely suspended upon steel knife edges, with a weight box as a counter balance. The stone hopper holds 1,000 pounds, and the clay hopper has about one-fourth of this capacity. As each scale hopper attains its proper weight the feed is shut off and a door in the bottom of the hopper is opened. While one scale hopper may attain its weight before the other, yet this hopper will not dump until the other one is full. This is regulated by an electrical connection, which is worked by magnets, controlling the mechanism of the doors. Thus the doors cannot be opened until contact is made through both magnets. The material when dumped is thrown together by means of "splash" plates below the scales and in a larger hopper from which the material is fed out through a small opening. An elevator now raises the mixed material to a large storage bin, where sufficient material can be stored to run the mill for twenty-four hours. Should the crusher be out of commission from this bin the material is fed to a rotary dryer, which is 60 feet long and 7 feet in diameter. This dryer is identical in operation to the one described before.

From the dryer an elevator raises the material to a

bin above the ball mill. This machine is an Allis-Chalmers type, and is a huge metal drum, lined with thick plates of chilled steel and containing 4,500 pounds of steel balls, each weighing from three to ten pounds. This drum revolves, and the constant rolling of the balls against the steel plates further pulverizes the material which is passing through the mill. On the outside of the mill are one-inch screens, and nothing larger than material of this size is allowed to pass out. Another elevator here raises the material to the top of the building, where it is dumped into a screw conveyor, which carries it to the bins over the fine grinding mills.

These mills are of the Fuller-Lehigh type, and are five in number. Their construction is as follows: A heavy ring of hard metal, concave on the inside, acts as a grinding surface. Four steel balls, each weighing 265 pounds, are pushed around this ring by means of a device which is revolved by a central shaft, which is driven by a belt from an electric motor. Above the ring is a casing, inside of which is a fine screen and a coarse screen, the latter acting as a protection to the former. Above the pushing device are several fan-like blades, which lift the finely ground material and cast it against the screen surface. The finest particles pass through, while the coarsest will drop back to be re-ground. The material which comes from these mills is of extreme fineness, 96 per cent. passing a screen having 10,000 meshes to the square inch.

From these Fuller-Lehigh mills the material, now in powder form, is conveyed to large bins by means of elevators and conveyors. These bins are located over the rear end of the kiln or "roasters." These kilns, which are four in number, are immense revolving cylinders, made of wrought iron, 125 feet in length and 8 feet in diameter. They are supported by four sets of idlers, each having four contact wheels. This cylinder is driven by a train of gear wheels, and by an ingenious speed-regulating device the kiln can be turned at any speed, from one revolution every two minutes to two revolutions per minute. These kilns are slightly inclined, so that material fed at one end will move by gravity to the other. Inside of the wrought iron shell there is a lining of fire brick 9 inches thick.

Below the bins where we left the ground material are large brick dust chambers, into which the end of the kiln projects. In the center of this dust chamber is a hanging brick curtain which tends to retard the current of heated gases, and thus deposits most of the fine dust, which otherwise would be lost through the stack. On the other side of this curtain is a stack or chimney 4 feet in diameter and 100 feet high. This also is lined with fire brick.

At the opposite end of the kiln are large bins or tanks, which are filled with powdered coal. This coal dust is fed through a double flight screw conveyor to a blow pipe, where it meets a current of air supplied by huge fans, which are located in the basement. The amount of both coal and air can be regulated by means of disc speeders and slides. The blow pipe extends through a hood, which closes the end of the kiln, and through this blow pipe is blown all of the fuel which supplies the heat necessary to burn the cement. When a kiln is started a large fire of wood is kindled inside, and when the fire is of sufficient intensity the current of coal dust is turned on and ignited. After this the combustion is spontaneous, and an intense heat of 3,000 degrees Fahrenheit is maintained in the kiln. This jet of living fire is projected onto the raw material, which has been fed into the end of the kiln by means of a screw conveyor and chute below the bins.

As the raw material slowly travels down the length

of the kiln chemical changes, brought about by the terrific heat, take place, and the material rolls up into little balls, the largest of which are about the size of a walnut, and these balls are vitrified and become black in color and as hard as stone. This is what is termed clinker, and drops into a "boot," where it is raised by an elevator and dumped on the clinker storage piles, which are outside of the building, exposed to the atmosphere. Here the clinker is allowed to remain for a month for seasoning. Tunnels run under the storage pile, through which bucket conveyors catch the cold clinker, which is drawn from above, and carry it to a belt, which conveys it to the finishing grinder room. Arriving here, the clinker passes through a crusher, which reduces the little balls to uniform size. At this point is added a small percentage of gypsum, which material is employed to regulate the setting time of the finished product. The material now goes into bins which feed the Fuller-Lehigh mills, such as were described before. In these mills the clinker is ground to extreme fineness, 96 per cent. of which passes a sieve having 10,000 meshes to the square inch, and 85 per cent. through a sieve having 40,000 meshes per square inch. This, then, is the finished Portland cement.

This cement is conveyed to the stock-house, where it is stored in large bins for at least a month before it is packed and shipped. This stock-house has a capacity of about 100,000 barrels. At one end of it is located the packing and shipping department. The system in use at this mill is known as the Bate Valve Bag system. This system has proven a great labor saver, and by means of it one machine and three men can accomplish in a day what formerly required the labor of a dozen men. The bags used are open at one end and closed at the other, with the exception of a flap, which acts as a valve. They are tied by a machine, by which one man in a day can turn out 3,000 sacks tied by a special knot, which cannot come untied. The packing machines are of peculiar construction, and fill four bags at one operation, which requires but eighteen seconds' time. One man supplies the machine with bags, while a second removes the filled sacks, each of which contain 95 pounds of cement. A third man receives the sacks on a truck and wheels them to the car, but a few feet away, where they are dumped in orderly piles. There are two of these packing machines, and together they can pack 3,000 barrels a day. The average carload of cement shipped is 150 barrels which is in the form of 600 sacks.

Below the packing house is the coal grinding house, where the lump coal is reduced to powder form for use in the kilns. The outfit here consists of a set of rolls for breaking down the lumps, a dryer manufactured by the Ruggles-Coles Engineering Co. of New York, N. Y., for driving off all of the moisture in the coal, and a Fuller-Lehigh mill for grinding the coal to dust.

The next building visited was the power house, which is one of the finest in the State. Here is generated all of the electricity which runs the motors supplying the different machinery with power. Two 1,000-horse power Hardie-Tynes cross compound engines run the two generators, which supply 600 kilowatts of electricity each. They run in perfect unison, and in all the great building not a tremor was noticeable. Extending across one end of the room is a switchboard of the most beautiful blue Vermont marble, on which are fastened all of the dials and switches necessary for registering and controlling the electric current. The writer was much impressed with this engine room, which is as clean as a new pin, and the machinery is kept in a shining state. Large windows

supply an abundance of light, and at night many clusters of incandescent lamps dispel the shadows and make an artificial daylight.

To one side of the engine room stands the battery of boilers which supply the steam for the engines. Here men, stripped to the waist, cast shovelfuls of coal into the never satisfied fire boxes, and so supply the food which maintains this mechanical monster. In this building is the air compressor, which pumps pure, sparkling water from three deep-bored wells into tanks raised on elevated towers.

The other buildings which the writer visited were the machine shop building, in one end of which is a supply room, carrying a large stock of material and repair parts, which are available at a minute's notice. The machine shop is equipped with lathes, drills, shapers and other machinery, by which may be repaired in quick time any of the machinery which may break down. In this building is also located a blacksmith shop, which is fully equipped for heavier work. Near by is a reinforced concrete oil house, which is absolutely fireproof. Here on a long shelf stand large tanks of the various kinds of oils used about the plant. In the center of this building is a cistern, into which any waste oil runs and from it can be pumped and used again.

As far from the dust as is possible, and yet near enough to the mill to be convenient, is the laboratory. At present this is but a temporary wooden structure, to be replaced at an early date by a two-story concrete structure. The inside of this building is fully equipped by many kinds of expensive apparatus necessary for the delicate work of analysis and testing. Here is controlled the various materials throughout the process, from the quarries until the cement is placed on board the cars. Day and night this constant supervision is maintained, and to this department is largely due the credit for the excellent quality of the cement manufactured.

At a short distance from the mill is located the office building, in which the offices of the manager, superintendent, bookkeeper, cashier, timekeeper and shipping clerk are located. A large draughting room occupies one wing of the building. The company has provided for the comfort of its employes by building cottages for its married men, and for the single men there is a large club house located in the town, in which are to be found all of the modern sanitary conveniences. About 200 men are employed in the different departments.

The output of the Atlantic and Gulf Portland Cement Company is now 1,200 barrels a day, and this will be increased to 3,000 barrels in a very short time. The factory is so located that "Coosa" brand Portland Cement can be readily shipped to any part of the South. In quality, color, fineness and sand-carrying capacity it stands second to none, and every one who has had an opportunity to visit the plant and examine the cement turned out is unanimous in the conviction that there is a great future ahead of the company, and at the low price at which they can manufacture, because of the wealth of limestone, shale and coal on their own property, is a sufficient guarantee of its financial success.

W. B. Shaffer, of Nazareth, Pa., is president; John S. Osterstock and H. K. Hartzell, of Pennsylvania, vice-presidents; George Crane, of Lancaster, Pa., treasurer, and W. S. Wilson, of Philadelphia, secretary of the company. M. W. Shaffer is general superintendent; Clarence N. Wiley, chief chemist, and the Kirkpatrick Sand and Cement Company, of Birmingham, Ala., general distributing agents for the company, handling its entire output.

PHILADELPHIA OPERA HOUSE.

On page 73 of our February issue we published a cut showing the Philadelphia Opera House which is an excellent illustration for cement plaster work on pilasters and arches.

Friends of ours ask us to call attention to the fact that, in addition to cement, sand-lime brick has been used in the construction of the building. We publish the cut once more and beg the reader to take another look at it.

all of the freight that was unloaded from the Missouri Pacific and Union Pacific team tracks was hauled across it, and I know of no bridge of its kind that has been subjected to such severe usages. Yet in spite of this, it did "business at the old stand," until it was removed by the C. G. W. Ry. Co., about a month ago. I think this speaks very favorably for a so-called "tin bridge"

"From an engineering standpoint, I hail with pleasure the advent of better bridges built under first class



Philadelphia Opera House Built of Sand Lime Brick.

CONCRETE BRIDGES.

The following address was delivered by W. H. Jones, before the Kansas Engineering Society at Topeka:—

"Wood was the principal material used in the construction of highway bridges in the past, and some very creditable structures were built of this material.

"The increased cost of timber and the necessity of having greater openings to carry the flood waters in the streams, introduced steel and iron as the main factor in the construction of bridges.

"To compete, however, with the low cost of the pile trestle construction, steel structures were and are designed so flimsy and light that they may well be termed "Tin Bridges." Yet they have performed, and do perform good work, considering their first cost, and it is surprising to note the very few accidents that have happened on account of the lightness of material used in their construction.

Good for Engineers.

"I recall a case of a bridge built over 35 years ago in the city of Leavenworth. This structure was built on very economical lines, and no unnecessary material was used in the construction. It possibly received a first-class coat of paint when erected, but I doubt very much if it has ever received a second coat that has been properly applied. This structure was located so that

specifications, and plans prepared by men well qualified in this specialty, and it is the duty of every member of this association to impress upon their associates, and the community in which he lives the fact that they cannot erect a first class structure at a second class price.

"The great trouble in the past has been that the element of the first cost has been the prime factor. I hope that the efforts of this society will bring about a new era so that the engineer and contractor can turn with pride to any structure they may build.

"I don't know if I have evolved to the point where I can take up the subject of reinforced concrete, but I am going to make the break.

Concrete Is Here to Stay.

"Concrete is a great friend, but we must not abuse it. There is an old saying "A little knowledge is a dangerous thing." A great many people outside of this profession have very little conception of reinforced concrete.

"I know of a case in a city in the west part of this state where a reinforced concrete sidewalk was constructed, and if my memory holds good, the span was between 25 and 30 feet, and the sidewalk about six feet wide. It was made of a slab 8 inches thick, reinforced by using some old barbed wire that had outlived

its usefulness. You can readily conceive that it cracked under its own load, and to remedy this defect, a cast iron column was placed under the point of fracture. I think you will all agree with me that this is a monument of ignorance.

"Reinforced concrete bridge construction is here to stay, and demands our careful study and research. I am emphatically in favor of first class concrete structures, and if constructed properly no better bridge exists at the present time. I am not, however, in favor of the use of concrete superstructure unless the case in question had received special study and analysis; the conditions of foundations, water, sand, rock each enter into the vital make-up of the finished structure, making every proposed bridge of this type a special study.

"If conditions warrant it, and the first cost is immaterial, I am strongly in favor of the use of reinforced concrete structures, when properly designed, and every detail of inspection and construction is strictly enforced. Otherwise, I am strongly adverse to the use of concrete in the main portions of the superstructure. For this reason, assuming for example, that through carelessness or otherwise, a shovel full of foreign matter is introduced into a batch of concrete. What happens? That batch of concrete is imperfect, and practically worthless, and may affect the existence of the whole structure.

"With proper care, namely, the painting possibly every two or three years of the steel work, the life of such a bridge is indefinite.

"I desire to mention in connection with the flooring of bridges that a creosote block flooring is giving desirable results, and also I understand that there is a cement manufactured in Colorado that neutralizes the effect of alkali.

Not Fit for All Places.

"You have in this city a bridge that represents one of the best types of reinforced concrete structures, and it was designed by first-class engineers, and I have every reason to believe that the contractors performed a very creditable job, yet there is evidence of imperfections, that may or may not be serious. I doubt very much the advisability of erecting structures of this nature in similar locations for this reason: It impedes the flow of flood water. With a steel structure in this location, with concrete floor, I believe that a great amount of damage done at North Topeka, during the flood of 1903, could have been eliminated.

"In closing, I desire to emphasize that a reinforced concrete construction must be first class in every respect; otherwise it is worthless. I hope that this effort will be instrumental towards the bettering of bridges throughout this "neck of the woods."



Concrete Bridge, St. Louisville, Ohio
Fred S. Culley, Engineer, Newark, Ohio
Illinois Bridge Co., Chicago, Contractors

Experienced Men Needed.

"Again, suppose through defective foundations, a crack develops in the concrete that admits the air and water to the reinforcement. What happens? We cannot see, but we can make a very fair guess. Eventually the bars will rust, and the structure will be worse than useless.

"The effect of alkali upon cement is very detrimental, and great care should be exercised that alkali in quantities is not present in water used in the mixing of concrete.

"Further, it is very imperative that the contractor be equipped with experienced men, and efficient tools to obtain desired results. Taking these elements of uncertainty into consideration, I am of the opinion that the best type of structure for general use throughout this country, is steel main members for the superstructure with re-inforced concrete floor. For this reason, when a steel structure is designed and manufactured, under proper specifications, it represents and is a finished product with no element of uncertainty, and the settlement, if any, of foundations, would not materially affect the strength or durability of such a bridge.

A NEW SWITCHING LOCOMOTIVE IN INDUSTRIAL PLANTS.

At present the switching of freight cars in industrial plants is a question which bears directly on the output of the plant. There are numerous cases where the switching is done by the railroad company's switching crew at such times as suits its convenience. Not that the railroad company does not want to assist the industrial concerns, but it takes some time for the switching crew to make hauls and place cars after they have been delivered on the company's side tracks, and to make the best of its time it is necessary for it to plan the work in such a manner that it can serve the greatest number of concerns in the least amount of time. This very often results in delay to the different concerns which are waiting to have cars and material placed.

The two channels forming the engine support are connected by a cast iron yoke bolted to the channels. The locomotive is arranged to run either backwards or forwards by the operation of a reversing lever in the cab. The locomotive is geared to a speed of six miles per hour when the engine is running at 400 revolutions

tions per minute, but the speed of the engine may be materially decreased by the timing of the spark.

The front and rear axles are both connected to the countershaft by a chain drive, the sprocket wheels being made of cast steel with cut teeth. The driving chains were tested to stand a strain of 44,000 pounds before applying. The bearings for the transmission and reversing shaft are bronze. At the opposite end of the locomotive from the gasoline engine is located the water tank, which supplies cooling water to the jackets. This tank has a capacity of 200 gallons and is bolted to the sub-frame. There are provided on the inside of the cab two gasoline tanks of 10 gallons capacity each. They are fastened to the subframe so that they can be easily removed from the locomotive at the time of filling.

The brakes are compound hand brakes and operate on all four wheels, the brake handle being interlocked with the driving clutch handle so that setting the brakes, automatically releases the clutch. The locomotive is provided with gravity sanders, one for each wheel. The couplers are the M.C.B. type and provided to swing at the draw head so that they can be coupled on cars standing on a curved track having a radius of 150 feet. A unique feature of the coupling arrangement is the installation of rods which allow the operator to uncouple cars without leaving the cab.

The cab frame is constructed of steel angles, and is provided with windows and a sliding door which gives the operator unobstructed vision of the tracks in all directions. The locomotive is provided with headlights and a whistle. The whistle is so arranged as to be operated from the exhaust of the engine.

It will be readily seen that with a locomotive of this description, the cost of fuel ceases as soon as the cars have been placed in position. It also allows the engineer to assist in other work than that connected with the running of the locomotive. One of the economical features of the locomotive is its ability to be started at a moment's notice, even though the engine may be shut down. It is entirely feasible to install gears which will permit of two speeds being used. This would allow the locomotive to return at a high speed after placing cars, in case the distance between switching points was great. There has already been quite an interest shown by industrial plant owners in this locomotive and it is possible that in the near future, locomotives of this type will find a considerable field in connection with industrial switching service.

The question of the cost of operation is vital in an installation of this kind. The tests so far made on this locomotive would indicate that the operating and maintenance expense per day amounts to from \$7.00 to \$8.00, which includes the consumption of fuel and oil, as well as the wages of the engineer, and interest and depreciation charge. This cost is based on a ten-hour day. Of course it is hard to say just what this expense would be to any one industrial concern as the conditions of each plant are different and consequently the work required of the locomotive varies under these different conditions. For instance, one company may have a number of cars to place early in the day and no more hauls to be made until evening, while another company may require the services of the locomotive every other hour during the day, or possibly continuous service.

The principal fact to keep in mind is that the great saving is not only in the low cost of switching, but in the advantage derived by a company, of being able to switch its cars as required. Another good feature of the locomotive is its ability to run in and out of shops, where a steam locomotive would be hazardous on ac-

count of the liability of dropping live coals. In fact this locomotive can go with safety any place that an automobile could. An additional precaution against fire risks is taken by making it necessary to remove the gasoline tanks from the locomotive in order to fill them. The tanks are so arranged that one can be in service while the other is taken away to be filled.

SAND LIME BRICK IN GERMANY.

Consul-General Skinner at Hamburg has sent to the bureau of manufactures at Washington a report giving new facts about the brick business in Germany. He says the annual product of sand lime bricks in that country has increased to nearly a thousand millions. There are 280 sand lime brick plants in Germany. The bricks cost less than \$3 per 1,000 to manufacture and sell for 50 cents per 1,000 less than clay bricks, to which they are superior in hardness and in smoothness. Nothing but sand and lime enters into their composition, and they are ready for use immediately after being taken out of the steam ovens in which they remain under pressure for eight hours.

The fact that anybody who owns a bank of good clean sand can, with a small plant, produce bricks, which are preferable to clay bricks for all purposes, ought to revolutionize the business of brick making in this country. But manufacturers are slow to change their methods when there is no developed demand for an improvement. Probably the extensive substitution of cement construction for bricks has had something to do with delaying the introduction of sand lime bricks in the United States. But these bricks at \$3 per 1,000 must be much cheaper than concrete, either poured or laid in blocks. Sand lime bricks can be made much larger than the ordinary clay bricks, thus making it possible to reduce the amount of labor in laying them. The consul-general at Hamburg says: "Because of their regular form and uniform dimensions these bricks can be laid more easily, and can also more readily be cut. This regularity of form and their trim appearance has led to a frequent use of lime sand bricks as facing stones, it being also possible to color them."

Some day, probably, the production of sand lime bricks will be as extensive here as it is now in Germany.

THE WEBSTER MFG. CO.

The well-known Webster Mfg. Co. of Chicago has just completed the erection of its immense shops at Tiffin, Ohio.

This plant is one of the largest of its kind covering four acres of ground. Its shops, foundries, engine rooms, and accessory buildings are fully equipped with the latest devices. The machinery is all electrically driven.

The sheet metal shop has an equipment of immense shears, presses and pneumatic riveters, and is further equipped with an air compressor for driving the pneumatic tools of all description.

The machine shop has a full equipment of large lathes and boring mills, and can take in 18 ft. to 20 ft. sheaves or pulleys; it is thus prepared to do the work of the largest character. Also this shop is equipped with a complete air-handling apparatus.

The malleable iron foundry has a capacity of some 20 tons per day.

The machinery is the most modern of any concern in the business. This enables the firm to turn out its products cheaper than other manufacturers.

THE INTERLOCKING TUBE SYSTEM OF CONSTRUCTION.

A new system of interlocking pile construction has been used recently in Chicago for piers, jetties and dock construction, and also for the building of walls and foundations. The construction is such that the completed work forms a solid and continuous wall, though composed of unit sections. The process consists in sinking steel tubes by jetting and loading and then filling them with concrete. Each tube or cylinder has on one side a hollow vertical rib and on the other side a hollow vertical socket, both of dovetail section. The rib of one pile enters the groove of the other, interlocking the piles. Since the tongue and groove are both formed in the steel tube, and both are filled with concrete, the completed piles are tightly locked together. The dock shown in the illustration can be duplicated, it is claimed, in twenty feet of water, at from \$45 to \$60 per foot, and can be built at the rate of fifty feet per day.

A later use for the same construction is in buildings such as the Interlocking Tube Co.'s factory shown above. Three walls were built of the interlocking units, and the front wall was of the standard paneled type. It is stated by the owners that the cost of the three walls of the new type was but little more than the cost of the one paneled wall, due to the fact that one-third of the labor cost is eliminated by the use of steel tubes. The tubes cost about the same as the lumber for the forms. In all cases the sheet steel tube remains in place.



The Interlocking Tube Co.'s Factory, Chicago, Ill.

THE RELATION OF THE ENGINEER TO LIFE.

An address at the annual meeting of the Western Society of Engineers by John W. Alvord, retiring president.

The constitution of the Western Society of Engineers prescribes that, among other duties, the president shall make an annual address to the society.

This simple injunction, framed in mild language, has nevertheless a sinister aspect, for it takes no account of the problem as to whether the president is capable of undergoing such a strain. It is true that we have had presidents who were poets, and others that were orators, and even some that would have perhaps graced the ministry, and the task of making an annual address would naturally sit lightly upon those so favored by nature. But the majority of engineers are neither poets nor orators, and the task of climbing out of the valleys up to the hilltops above the mists of detail, to

gain some clear vision of the broader life of the engineer, is indeed an arduous one.

Years ago, when I knew more than I do now, I had the temerity to attempt a satire on the usual annual presidential address, and, in particular, to hold up to ridicule that somewhat overworked definition of the engineer, "as harnessing the forces of nature to the use of man." My punishment, though long delayed, has been none the less merited and sure, for I realize to-night, as I stand here before you, that if there is one occasion upon which we must needs feel reverence and sobriety, it is as we try to define the broader meaning of our work in life and its possibilities.

I have, therefore, after some thought, chosen to speak to you to-night on three reasons why our profession is an ennobling occupation, and three reasons why, in my opinion, many engineers, especially the younger men, do not rise to a clear conception of their opportunities.

The charm of life, that which gives it its zest and inspiration, is to do useful work for our time, our place and our generation; to realize that we are needed in the progress of things, and even at times appreciated; to feel that we are pushing the world a little inch uphill, and to receive as our reward, not altogether financial return, but, as well, the sense of that indefinable indebtedness which all must feel toward a useful profession; that is to say, appreciation.

I know of no body of men of whom this may be more truly said than the profession of the engineer, and it cannot be impressed on us too strongly that we who are engaged in this useful occupation are fortunate in

having a calling whose broader aims shall constantly buoy us up and tide us over the mishaps, the disheartening accidents, and the daily grind of a life work which is all too full of drudgery and detail, if we permit ourselves to forget its possibilities.

There are, I think, three well-defined reasons why the occupation of the engineer is an ennobling one, and of these three I wish to briefly speak.

First, the engineer is the original conservationist. It has quite recently been given to the politicians and to others of strenuous life to discover this fact—that the engineer, who has been at work since the days of Tubal Cain, is the true and original conservator of natural resources. Of this there can be no dispute. Where the work of the engineer exists; where his thoughtful predeterminative and creative task is properly allotted, and carefully studied, there is conservation, there is the elimination of waste, there is the precise applica-

tion of the resources of nature for the use of man, with no undue loss. We must, therefore, as a profession consistently claim that we have been newly rediscovered, for we have always existed, and that the conservation movement in all its novelty and all its breadth and all its newness is but an effort on the part of society at large properly led, to appreciate the calling and work of the engineer.

Everybody is agreed on the nobleness of purpose which has emanated this thoughtful conservation movement; everybody is agreed on the altruism which would save for our children and our children's children the great natural resources which Providence has placed at our disposal, and everybody is agreed that the work of preserving these natural resources, of properly utilizing them, of conserving them, is an ennobling calling. So much has been said on this subject recently

rowed in tunnels; has endured the hardships of cold and heat, and rough and uninteresting associates—a veritable missionary of truth; courageous, animated with high motives, though not always recognizing that; stirred with feelings of usefulness to humanity, though not always aware of even that; but inarticulately expressing in his life of devotion the larger and deeper motives which come to the teacher, the soldier, the scientist, and the missionary of the Gospel, which cause them to forego the pleasures of wealth, society and ease in that larger and nobler sacrifice which appeals so deeply to humanity because of its altruistic nature.

And not alone in the desert or the mountains are such sacrifices made, but problems of great populations and congested municipalities require the same patient effort in teaching the useful arts and enlightening men



Detail of the Interlocking Tube Co.'s Dock
Elston Avenue and Chicago River, Chicago

that I think I need not unnecessarily dilate upon it. I congratulate the profession that we have been removed from our temporary hiding places and held up by the chief of all strenuosity to the gaze of an admiring and appreciative world, and I trust that it will result in more cordial relations between ourselves and the public whom we serve.

Second, I wish to point out that the work of the engineer is an ennobling calling because he is what may be termed the missionary of science. There are indeed those among the engineering profession to whom has been given the opportunity to develop discovery of pure science in the course of their occupation; to advance our knowledge of natural law for the sake of truth itself without regard to practical application, and we cheerfully honor those who have had this high opportunity. Most of us must be content with the knowledge that it is our lot in life only to keep abreast of the discoveries of science, and be able to so usefully apply them that their benefits may reach the masses of people who would otherwise have no time or means or ability to grasp the treasure-house of truth directly.

In this work of bringing to humanity the benefits of scientific research, the engineer has had to make and will have to continue to make great sacrifices. First of all, he has to be an educator to contend with prejudice, with doubt and with ignorance; to lead patiently and gently the mass of men to understand how best they may better their condition; to guide them against over-enthusiasm on the one hand, and impractical expenditures on the others; and to lead them into the enjoyment of all that science holds for them in ordinary advancement of life through the aid of their useful art.

In this work the engineer has penetrated the forest and the deserts, has lived the life of self-denial in camps, isolated from all useful environment; has bur-

as to how they may wisely and comfortably live together. All this is the work of the engineer in the advancement of civilization. To improve the sanitation of our large cities, purify their water supplies, improve their transportation and comfortably house vast populations in congested territory require the utmost patience and tact in dealing with ever-changing boards, councils, corporation officers and those empowered with responsibility.

I cannot conceive of a more ennobling calling than that which I have here described, a calling involving the teaching of useful scientific truth to the mass of men, of educating humanity to the possibilities afforded by the adaptation of science to daily life.

And, third, I wish to point out that professional engineering is an ennobling calling, because the engineer is, in the higher aspects of his work, a creator. The highest development of nature is life, and the highest development of life is thought, and among the highest developments of thought is creative imagination. In this respect man stands alone in the universe, pre-eminent and conspicuous, God-like in his attributes; to him alone is given the opportunity to conceive, to depict, to create, and then by slow, patient steps to convey this impression first upon the paper, and then step by step carefully to transfer it to reality in the structure.

A thought must precede every useful act. The mason who lays a brick must either consciously or subconsciously imagine that brick in its proper place before the reality can be attained. The carpenter must have a constructive thought before he drives a nail; he must conceive a method before he raises a roof rafter, and in like manner the architect must have a picture in his imagination before he makes a sketch for even the humblest cottage. So it is a necessary talent of the engineer, even in the humblest parts of his work,

to preconceive, to originate, to design, to create, and in this respect he is on a par with the artist, the poet, the musician or the writer. Yes, even more, because in all his work comes the element of a practical utility which makes it doubly useful and gives it tremendous meaning in the advancement of the fine art of living.

Now, I have said a good deal about the call of our profession to a better purpose, a good deal about its ennobling character, and the question naturally arises in the minds of all who duly appreciate all these things, are we struggling toward these ideals? Do they lift us up, and if not, why not? It is a wise man who knows how to examine himself for his deficiencies, and it is not unfitting or improper that a profession should at times become introspective, and demand of itself, as would an individual, to know if it is fulfilling the call to high motives.

I have asked a good many of my friends during this past year why the profession of civil engineering did not turn out more marked men—men of broad capacity; men of high ideals; men of large affairs. Many have answered me that it does, and this must be admitted in a large degree, and yet the question comes, why not in a larger degree? Are there any real reasons why we are hedged in, down-rod-den, not appreciated, and do those reasons lie within or without the domain of our own endeavor?

Classifying some of the discussions which I have had on this subject, they resolve themselves, it seems to me, into three major reasons why the engineer does not always lay hold, to a larger degree, upon the inspiration and opportunity of his calling. These reasons are, first, that he naturally and necessarily so immerses himself in the details of his work that he cannot always get the broader outlook, the higher culture, that would come from an enlargement of his field of view. It is natural and proper, in a profession which is so exacting in its details, that the young man particularly should busy himself to an unusual degree with the accumulation of data. He must master these if he would get up to the next step in the ladder. They are the stepping stones by which he grasps the broader principles, but it comes to men in later life that, after all, the underlying principles are simple, and that all facts fall into easy classification when we understand the broader principles which underlie them, and at least from this point on it seems to me that the engineer should devote himself more and more constantly to general culture, to wider reading, to broader perceptions, to higher ideals than occurred to him or were afforded him in his first efforts to get an understanding of the life work which he has chosen. The engineer needs a wide horizon; he needs more study of human nature; he needs to know more about the science of organization, of political and social economy, of finance, of business, and of common sense. These portions of his equipment are not always taught in the college, nor are they usually impressed upon him until he comes into contact with men who notably possess them. They are a necessary part of the success of every man who would be a leader, and there is no reason why the engineer should not be a leader among men.

A second reason which I have gathered from much discussion of this subject has been voiced or might be voiced in the complaint that, as a body, the engineering profession (and especially sometimes the younger members who have not caught a glimpse of its ideals) is not always quite loyal to it. There are too many heartburns over the success of a fancied rival; there is altogether too much jealousy, especially among those who are struggling to get a footing. There is, above

all, a considerable lack of appreciation of the value of association; engineers are not always prone to remember that they are part of a brotherhood, and that their predecessors and contemporaries have put on record, for the benefit of their profession and posterity, a vast mass of information, without which we could do no useful work. We are all deeply indebted to those who have placed useful information on record, and we pay our society dues cheerfully to aid in this good work. If this sense of obligation could be deepened, especially among the younger men, it would, I think, go far to remove that lack of loyalty which some of us are apt to show in our relations with our profession. I am aware that there may be differences of opinion upon this subject, and there has been advanced the opinion that engineers, as a rule, work together more heartily and cheerfully than do most of the other professions.

I would point out that this seems to be true exactly in proportion as civilization in different parts of our country has advanced. In the older settled communities, it is especially true that there is great loyalty to the profession as a whole. In the newer communities this condition is coming to be realized, but it has not as yet attained that stage which should be desired. Further, it may be pointed out that it seemingly becomes the truer the older a man becomes. The younger men do not always see clear on this question of loyalty to their profession. To them there is a heart-breaking experience of patience and slow progress, for rapid financial rise in the engineering profession, or any profession for that matter, is not usually desirable. Experience must come with years, and with the years also come clear and broader views of the elemental and underlying principles that must be our guide. Youth has but a peep into the vast world of knowledge which lies before it. The young man usually becomes embarrassed with the vast masses of details which apparently he must absorb. Later, fundamental principles dawn on him. Among others comes usually this recognition of his indebtedness to the profession that has recorded information for his benefit.

It would seem to me, therefore, perhaps fair to say that often with youth and often with lack of association and often in the newer civilizations there is somewhat lacking that loyalty to the profession that would make its great ideal clearly perceived.

In the third place, many have suggested to me that one of the reasons why the engineer does not rise to an appreciation of his calling lies in the fact that he so often makes the mistake of placing the dollar ahead of useful service. This is a temptation which comes with peculiar force to the younger members of the profession, but alas! many older men are not free from such fallacy. No more deadening or pessimistic view could destroy the noble aspects of a life work in anything altruistic than to have its success measured by salary or emoluments. Do not misunderstand me; it is right and proper for all of us to see to it that our work is worthily and properly remunerated. Self-respect will not allow us to do otherwise, and we can all of us sympathize with the old darky preacher whose meager salary had not been promptly forthcoming when he said somewhat plaintively to his Sunday morning congregation, "Bredren and Sistern, things is not as they should be. You all must not 'spects I can preach on earth and boad in Heben."

To measure our success by financial remuneration; to set first in our imagination the amount which we are to receive for services over and above the best possibilities for usefulness, is a most fatal mistake. Nothing seems more pathetic than to see a youth measuring

his job by the amount of money he can get out of it. He reminds me of the story of the two Hebrew gentlemen, who while traveling with their wives on a railroad train were wrecked, both injured and taken to a hospital. A month or two later they met on the street, and Mr. Cohen said, "Vel, Levy, how much did you get out of it?" "Five thousand dollars," said Levy. "Good for you," said Cohen, "das iss fine." How much did you get out of it, Cohen?" said Levy. "Ten thousand dollars," said Cohen. "Mein Gott," said Levy, "ten thousand dollars, and I only got five thousand; how did you do it?" "Dot vas easy," said Cohen. "Yoost as der accident habbened, I haf der presence of mind to kick my wife in der shins." Now, I am afraid a good many young engineers, who are continually looking about them for more pay, regardless of their usefulness in their present work, are, so to speak, "kicking their job in the shin."

Life, says a great poet, is the fiber with which the soul learns to weave.

Life is a study in adaptation; it is the development of character through our struggle with environment; that is to say, the effort to so order ourselves, that we adapt ourselves to the laws of nature. To make nature serve our higher purpose is the first struggle of mankind. Second to this is the art of adapting ourselves to each other, through the science of human society. Through these two adaptations we strive, progress, achieve and idealize. We epitomize these adaptations in common language by describing the man who has in some manner attained them as having "common sense"; that is to say, the sense of common things which control us fundamentally.

Pre-eminently these are the cardinal principles of the engineer; his watchword; his diploma; his goal. Above all things, he is to keep his feet on earth; to be practical; to be conservative; to see all sides of his problem; to have the judicial mind; to find the path of least resistance whenever that path is an honorable one. This is "common sense." Sometimes it is called "horse sense." I heard a story recently of a gentleman who lost his horse and offered a reward of \$5.00 to any one who would find her quickly. A half-witted fellow in the town, after half an hour's search, returned, leading the animal by the bridle. The owner, surprised at the ease with which the horse had been found, asked, as he handed over the money, "Tell me how you found him." "Wa'al," said the fellow, "I thought to myself, where would I go if I was a hoss; I went there and he had."

In conclusion, I would repeat again my text:

That the charm of life, that which gives it zest and meaning, is to do useful work for our time, our place, and our generation; to give more than we receive; to place usefulness ahead of emolument; to push the world a little inch uphill, and to plant a flower in everybody's garden but our own.

A meeting was held by the Marquette Cement Company and officers were named for the ensuing term. All the old officers were re-elected. The list is as follows:—President and Treasurer, N. W. Duncan; Vice-President and Gen. Mgr., Theo. Dickenson; Vice-President in charge of sales, Wm. Dickenson; Secretary, Edw. J. Dalton; Assistant Treasurer, Stuart Duncan. Plans are being made for the expenditure of a large sum of money for the improvements at the plant.

CONVENTION OF ENGINEERING CONTRACTORS.

The American Society of Engineering Contractors, 13 Park Row, New York City, of which Mr. D. E. Baxter, of 27 Williams Street, New York City, is President, and Mr. D. J. Hauer, secretary, will hold their annual convention in St. Louis, on Sept. 27, 28, and 29, in the coliseum. The local committee of arrangements is E. H. Abadie, Chairman, J. L. Westlake, W. C. Swartout, and L. C. F. Metzger.

Papers will be delivered by J. B. Goldborough and Ed. Wegmann, both of New York, on Dam Construction for City Water Supplies, and by George C. Warren of Boston on Work Preliminary to Street Paving and Road Work. A banquet will be held, and several sight seeing trips will be made to important engineering work in and around St. Louis. This society now has nearly 800 members.

It was the original intention to suspend the truss on a mast in such way that the angle it makes with the ship's deck could be changed to compensate for the rise of the ship and fall of the barge as the barrels are taken out of one and loaded into the other. The tests show that the large range provided will be unnecessary, and the compensation will be made by hydraulic jacks resting on the deck and acting against the lower side of the truss, and by altering the chains by inserting or removing links. The capacity of the unloader is limited by the ability of the laborers in the barge to take away the barrels as they are deposited. Three hundred barrels an hour is an economical rate, although this may be doubled if the loading and unloading rates are in-

The contractor to whom the contract for furnishing a complete set of barrel and bag unloaders was let in August, 1909, also made a test of an improved conveyor in the week of August 1-7. The conveyors first constructed by the contractor failed to work satisfactorily and a new conveyor on the plan of that constructed by the Commission has been built. It differs from that built at Gorgona shops, in the method of carrying the barrels, using hooks instead of the chain loop. It unloaded 4,300 barrels on the test, but will have to be altered before it does its work satisfactorily.

GLIDDEN VARNISH IN SOUTH AMERICA.

The Glidden Varnish Company has sent a special representative to South America to place their CONCRETE FINISHES and WATERPROOFINGS among the Architects and Engineers. Their Mr. Tornado a native of South America sailed on the 25th of January to locate permanently in Buenos Aires, where he will have entire charge of the development of the CONCRETE COATING business of The Glidden Varnish Company, as pertaining to South American countries.

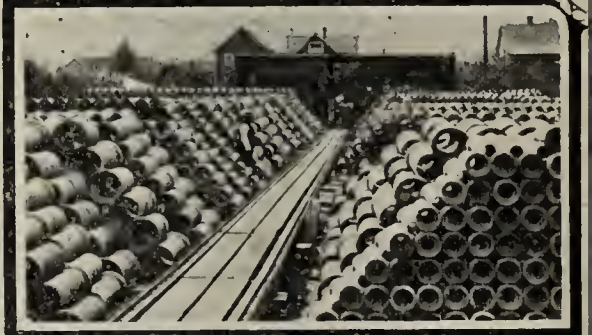
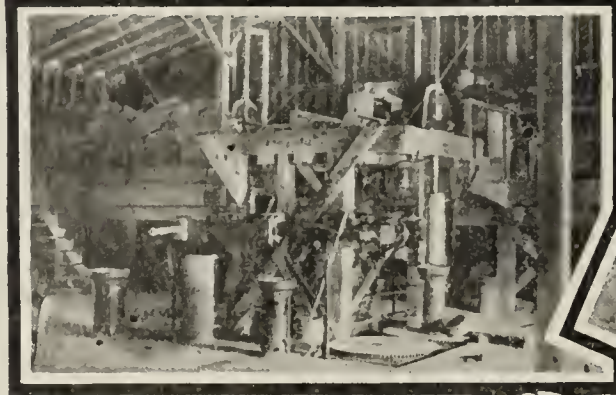
Demands for the GLIDDEN PRODUCTS are coming from every quarter of the globe and their export business during the past year in CONCRETE FINISHES was enormous. Their principal sources of outlet are India, South Africa, China and South America.

CEMENT CHEMIST GOING ABROAD.

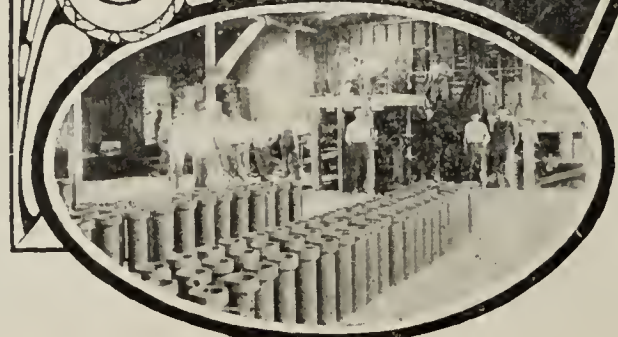
Mr. W. B. Cady, the past three years chemist for the Penninsular Portland Cement Co., of Cement City, Mich., leaves Feb. 4. for Europe.

Mr. Cady while abroad will make special studies on cement chemistry of that country. He will return about the middle of next May.

Views of A Number of The Cement Sewer Pipe



1. Pipe ready for laying.
2. Dominion Plant, Vancouver, B. C.
3. Tacoma Plant, Tacoma, Wash.
4. Iowa Plant, Griswold, Iowa.
5. Pipe.
6. Boise Plant and Pipe, Boise, Idaho.
7. Portland Plant, Portland, Oregon.
8. Lewiston Plant, Lewiston, Idaho.
9. Salt Lake Plant, Salt Lake, Utah.



Plants Established in the West and Their Products.



THE MANUFACTURE OF GLAZED CEMENT SEWER PIPE.

Remarkable as have been the developments of the past ten years in the field of cement and concrete, and prolific as that field has been with new products and inventions, there is no doubt that the invention of James Thomas, of Tacoma, Washington, is second only in value to that of Portland cement itself.

All cement workers and users of cement, or concrete, are cognizant of the protection that a well troweled coat of neat cement gives to all exposed surfaces, as well as those under pressure and subjected to other liquids than pure water.

The invention of Mr. Thomas, known as the Thomas glazed cement sewer pipe machine, is what does the business. The principles upon which this machine has been developed include automatic troweling and tamping; the troweling produces the interior glaze, and the automatic tamping uniform density and homogeneous texture. The trowel effect is brought about by a stationary core of polished steel and a potter's wheel; the automatic regulation of the tamping is one of the unique features of the machine.

The machine occupies a ground space 17x10 feet, and is 7 feet 10 inches high. Each machine is a double header, that is, it is built for the manufacture of two pieces of pipe at the same time; usually the ends are constructed to accommodate different molds, one for the smaller and one for the larger sizes.

An overhead shaft operates the feed and the stem of the core; an underneath shaft operates the tables, and all of these movements are controlled by levers which are handy to the machine man.

Sunken tracks at each end of the machine support a carriage with two tables, or potter's wheels. One of the tables is in operation making pipe, while the other is being relieved of its pipe and an empty mold put in place. The tables are 36 inches in diameter, bored with a series of concentric lug holes, which provide an easy means of shifting from one size of pipe to another. Pipe may thus be readily made in any of the standard sizes from 4 to 30 inches in diameter. The molds are made of steel and fitted on the outside with toes to engage the lugs in the wheel and thus made to revolve with it.

The table has a fourfold function: distributing the feed, equalizing the tamping, troweling the inside of the pipe, and assisting in the discharge of the core, all of which is accomplished while the table is in motion.

The product is one in which the various objections that have heretofore been advanced against cement pipe, for general or specific purposes, are eliminated. It will be noted that a mechanical means has been arrived at by which uniform density is assured, as well as a uniform texture; that this same machine puts on the inside of the pipe a glazed finish that overcomes the objections to porosity, and withstands the effects of substances which ordinarily cause any other make of cement pipe to disintegrate.

The pipe has won its way to acceptance and use in Vancouver, B. C.; Tacoma, Bellingham, Everett, Aberdeen, and Spokane, Washington; Portland, Medford, and Salem, Oregon; Boise and Lewiston, Idaho; and Salt Lake City, Utah. And in so doing it has had considerable bearing upon the civic interests of those communities. Better pipe, both clay and cement, has resulted. The people have awakened to the fact that the competition of this pipe has been instrumental in giving them full values on all improvements where pipe is used.

Pictures of several plants operating glazed cement sewer pipe machines and making glazed cement pipe are shown on the preceding pages.

SAND-LIME BRICK INDUSTRY IN AUSTRALIA

The sand-lime brick industry in Australia, as developed by American machinery and methods, is proving a great success, both for the local manufacturers in Australia and the firm of engineers who have erected the factories.

During the past year the International Sand-Lime Brick & Machinery Company, 90 West Street, New York, have erected and completely equipped two of their Standard Single Unit factories—one at Melbourne, the other at Adelaide—each with a capacity of 20,000 brick of standard size and 200 cubic feet of stone per day of ten hours. These plants were erected for a local Syndicate, who have purchased the Letters Patent for the DIVISION METHOD, which is owned and controlled exclusively by the above Company. Mr. D. W. Cummins, well known to brick manufacturers in the United States, has been in charge of the erection of the new factories in Australia. A recent report from Mr. Cummins, just after the completion of one of the plants, indicates the success with which the business has met, and the prospects for the future:

"Everything here is going on very well. We are making the finest, hardest and best brick in the world. They have no equal in America, and we have struck the best lime we have ever handled. We have also made a few stones—just simply out of sight, for appearance and hardness, and cannot be beaten—and they expect to do a big business in this proposition alone. It is safe to say that within six months' time both factories will double their capacity, as the demand for the bricks is so great that they cannot fill the orders."



Sand Bank, Melbourne Plant.

With this report were received a few photographs of the Melbourne Plant, which we reproduce herewith. Number One gives a general view of the exterior. Number Two is an interior view, showing the "International" four-fold Press in the foreground. Number Three shows the sand deposit and the manner of conveying the sand from the same to the factory.

As can be seen from the interior view, the brick made in Australia are of much larger size than ours in the United States, being $8\frac{7}{8}$ in. x 4 5-16 in. x 3 in. The capacity of each factory is about 15,000 brick of Australian size in eight hours. The schedule of labor and material for a day's run in these factories is as follows:

One (1) Foreman,
 One (1) Engineer, (does his own firing),
 One (1) Fireman, (Night Watchman),
 Eight (8) Common Laborers,
 (52) Tons Sand,
 Three (3) Tons Lime,
 Three (3) Tons Steam Coal,
 Oils and Waste amounting to about \$2.00,



General View, Melbourne Plant.

Average estimate for Repairs wear and tear \$5.00.

The equipment of these factories, furnished entirely by the International Company, is of the regular Standard "A" Schedule, the same as they are installing in the Single Unit Factories in the United States. The plans and specifications have been prepared by this Company, and the factories were erected under the supervision of their experienced engineer, Mr. D. W. Cummins.

Considering that the Sand-Lime Brick Industry in this Country is but in its infancy and that the German manufacturers of this class of Machinery had entered the field in Australia, it goes far toward proving the superiority of our American Methods and Machinery. that the Australian Syndicate is placing additional orders for Machinery for other factories in Australia with the International Sand-Lime Brick & Machinery Co., having also acquired the Australian Patent Rights of the "DIVISION METHOD" for the preparation of the material, as owned and exploited in the United States by this Company, and, altho the German manufacturers are offering Machinery at lower prices, the Australian Syndicate, after a thorough investigation of the entire industry in this Country and in Europe, finally decided to do the business with the International Company, and judging from the letters received they are more than pleased with having come to this decision.

LEHIGH FRICTION CLUTCHES.

The Lehigh Clutch is a Rim Friction Clutch, with positive action and grip, is easily adjusted and has special features which make it the most powerful clutch on the market.

It is admitted by the highest mechanical authorities that the "Rim Friction" Clutch is superior to any other type of clutch for severe and continued service, and the Lehigh Clutch, with its simple, quick and positive adjustments, is the best of them all.

This clutch is of the opposite jaw type, as may be seen from the illustration, (see page 141) each jaw being operated by an independent lever, which is con-

nected to the spool by a turnbuckle. This turnbuckle serves to adjust the clutch when the shoes begin to wear.

One of the distinctive features of the Lehigh Clutch is the method of adjusting each jaw without disturbing any other jaw on the clutch, thus insuring a positive grip of each shoe on the rim, making the Lehigh Clutch capable of transmitting considerable more power, safely

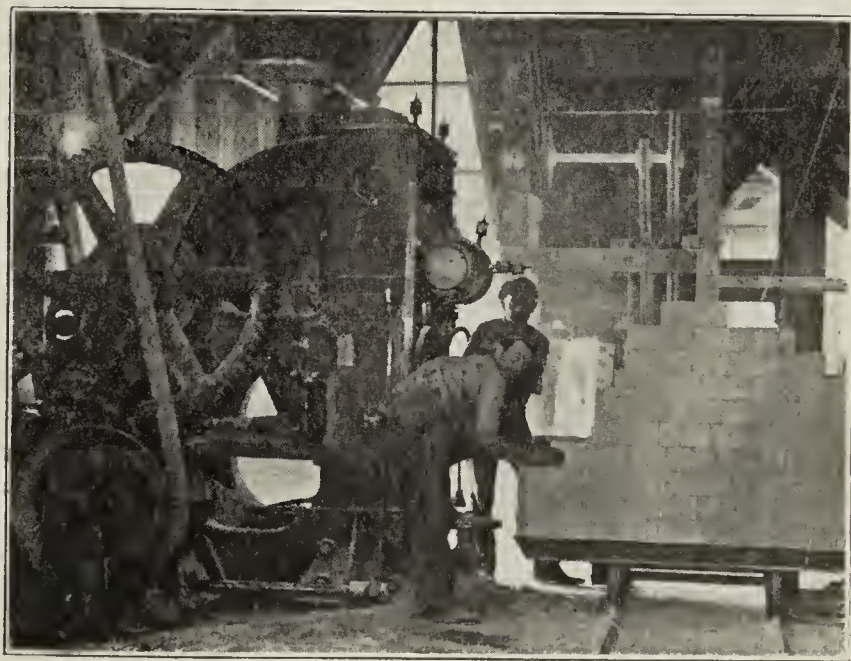
than a clutch on which the jaws are adjusted in pairs and when one shoe must wear down to conform to the other shoe before a perfect grip is obtained on the rim.

The wood shoe or friction block on any jaw can be removed without disturbing either of the other jaws, or without removing the clutch from the shaft.

No springs are used to release the clutch, but the jaws are moved from the rim by positive acting levers, which are so arranged that the shifting lever is operated very easily.

The Lehigh Clutch is especially adapted to high speed, and is suitable for electrical drives and any machines where a quick acting, powerful and safe friction clutch is required.

All parts subjected to severe strains are made of



Machine Room, Melbourne Plant

Malleable Iron; the jaws are made of semi-steel, and the spider of special mixture of Iron.

Each piece of the Lehigh Clutch is finished in jigs, making it interchangeable, and easy to replace worn out parts.

When sending inquiries or orders, state character of service, and whether load is steady or intermittent.

If used for gas engine service, state number of cylinders on engine, and if single acting or double acting.

A FIREPROOF COTTON STORAGE BUILDING.

The problem of fireproof construction for buildings designed to accommodate large amounts of inflammable material or in neighborhoods where fire risks are high, is a most important one under modern conditions of construction. The rapid growth of reinforced concrete construction has in many cases made possible a satisfactory solution of this question. Although the first cost of concrete is higher than most other types of construction, the fact that there is practically no depreciation to be considered is a strong argument in favor of this type.



First Floor under Construction, Pile Driving not yet Completed.

A notable example of the use of this type of construction for a fireproof warehouse is that of the new cotton storehouse of the Massachusetts Cotton Mills at Lowell, Mass. Not only is this building probably the largest concrete structure of its kind but in its design there are several noteworthy features. Furthermore, its erection was accomplished in a remarkably short period of time.

The building is 100' by 256' in size and stands twelve stories high. It is situated in the heart of the city of Lowell on a block, the surroundings of which were such that very careful planning was necessary in order to assure the arrival of the material at exactly the proper time. The available storage space being exceedingly limited great care had to be exercised to make sure that there was no congestion and at the same time no delays.

The designers were the Company's engineers, Messrs. Lockwood, Greene & Co. of Boston, and the entire contract for the construction was placed with the Aberthaw Construction Co. of Boston, Mass. The interior design of the building consists of mushroom columns and reinforced concrete slab floors. This girderless design permitted of very low story heights, the total distance between the floors being only 8 ft. The columns are of latticed steel encased in concrete and the exterior walls are of solid reinforced concrete for the first three stories and concrete panelled with brick for the upper stories. A very heavy concrete cornice encircles the top of the building and this feature combined with the brick panelling and the grooving of the concrete surface on the first three floors give the building a remarkably handsome appearance. It was, in fact, a part of the designing engineers' plan to have this building as handsome architecturally as it is effective for the uses to which it is put.



Laying Concrete for Girders and Foundation Piles.

There are five rows of columns spaced 16'8" on centers with twenty 16' longitudinal bays. Three reinforced concrete fire walls extend the width of the building and divide each floor into four separate compartments. These fire walls as well as each row of interior columns, rest on heavy reinforced concrete transverse girders running the width of the building. The girders carrying the fire walls are supported on three rows of Raymond concrete piles and the column girders are supported on two rows of piles. The building walls are likewise carried on concrete piles there being in all some 1400 piles in the foundation.

Along the rear of the building there is a concrete loading platform which serves two elevators. Each of the latter is alongside one of the end fire walls so that it serves two of the compartments on each floor. Automatic fire doors guard the elevator openings to each compartment. Each of the four sections is also provided with a series of traps for lowering material to the ground floor. These traps are also provided with automatic fire doors so that in case of fire in any one room it would be confined entirely to that room. The windows are set in pairs between the concrete panels; they are of sheet metal with glass panes, the whole being of very heavy and fire resisting construction.

A bridge connects the storehouse with another building of the mills across the intervening street. This is constructed of structural steel covered with corrugated iron. In one end section of the ground-floor, which is used as the breaker and opener room, the second story is omitted in order to give an in-



Completed Building.

creased amount of headroom, so that there are in all 47 separate compartments in this building. Each of these has been made both fire and waterproof. A fire might take place in the stored cotton in any one of these separate compartments without endangering in the least the safety of the remaining material or of the building itself.

From a construction standpoint several difficulties presented themselves in the course of the work. It was the wish of the owners to have the building completed in as short a time as possible, and the space available for the storage of materials was exceedingly limited. The Aberthaw Construction Company introduced somewhat of a novelty by the use of corrugated iron forms for the girderless floors throughout the building. These forms were much easier to erect and remove than are the ordinary wooden forms and the corrugations added considerable to the appearance of the finished ceilings. A further replacement of wood by steel on this job was in the construction towers used. These were made of interchangeable sections of structural steel which could be quickly bolted together and this built up to any desired height. These towers, which were designed by the contractors, were taken down at the completion of the building and are to be used on other building operations, the depreciation from use being very small.



View of Interior.

The speed with which this building was erected probably marks a high point for this kind of work. The piling was completed in July 1910 and the finished building was ready to be turned over on the first of January 1911. The method followed was to begin placing the reinforced concrete girders for carrying the building columns as soon as a line of piles had been placed. In this way the general contractors followed the work of the Raymond Concrete Pile Company closely and the last girder was placed a short time after the final row of piles had been driven. Early in August, during the erection of the second story, the maximum speed of erection was reached, that of one floor per week which was maintained until the completion of the top story. The actual structural work was practically completed by Nov. 15th and the closing in well along. The last month and a half of the year was occupied in bricking up the panels, setting the windows and doors, installing the sprinkler system and similar finishing work.

In its design, the methods employed in its construction, and the appearance of the completed building, this warehouse undoubtedly eclipses any similar building heretofore constructed.

TESTS TO DETERMINE THE VALUES OF CLAY AND REGROUND CEMENT FOR SECURING IMPERMEABLE CONCRETE.*

The work was to investigate the value of reground cement and clay as waterproofing materials in cement mortars and concrete.

Cement.—Northwestern States Portland cement was used. Tested in the laboratory it was found to conform to the specifications of the American Society for Testing Materials.

Reground Cement.—The reground cement was made from the ordinary factory product by grinding it for 14 hours in a ball mill, in the cement laboratory. About 10 lbs. were put in each cylinder at a grinding. The average fineness of the three grindings made was 98.5 per cent passing a No. 200 sieve.

Sand.—The sand used was obtained from a pit near the college, all being used which passed a No. 8 sieve. The sand analysis was as follows:

Retained on No. 8 sieve	27.75 per cent.
Retained on No. 20 sieve	22.66 per cent.
Retained on No. 30 sieve	12.35 per cent.
Retained on No. 50 sieve	27.75 per cent.
Retained on No. 100 sieve	7.20 per cent.
Retained on No. 200 sieve	0.72 per cent.
Passed No. 200 sieve	1.44 per cent.
Total	99.87 per cent.

The voids were 36 per cent. The amount of clay was 3.5 per cent.

Clay.—The clay used was of good quality, free from sand. It was dried at a low heat for 24 hours and was then ground until 98 per cent passed a No. 200 sieve.

Stone.—The stone used was a good quality Iowa limestone, broken to pass a 1.5 inch ring. All dust passing a No. 8 sieve was removed.

Mixtures.—The mixtures used were as follows: 1 common cement to 2 sand; 1 reground cement to 2 sand; 0.9 common cement to .1 clay to 1 sand; 0.85 common cement to .15 clay to 2 sand; 1 common cement to 3 sand; 1 reground cement to 3 sand; 0.9 common cement to .1 clay to 3 sand; 0.5 common cement to .15 clay to 3 sand; 1 common cement to 2 sand and 4 broken stone; 1 reground cement to 2 sand and 4 broken stone; 0.9 common cement and .1 clay to 2 sand and 4 broken stone; 0.85 common cement and .15 clay to 2 sand and 4 broken stone; 1 common cement to 3 sand and 5 broken stone, and 1 reground cement to 3 sand and 5 broken stone. In the mixtures of clay and common cement, the clay replaced part of the cement.

Mixing.—Proportioning was by weight. The mixing was done by hand; as nearly as possible imitating actual operations as practiced in the field. In the case of the clay it was first mixed with the cement and then with the sand and broken stone. In filling the forms the material was well tamped to make as dense a mixture as possible. The test specimens were made by filling forms of corrugated galvanized iron, each in shape the frustrum of a cone; 4 ins. in diameter at the larger end and $3\frac{1}{3}$ ins. at the other. These were filled to within 1 in. of the larger end. Two sizes of test pieces were used—6 and 3 inches thick—and three specimens of each size for each mixture were made, making 84 specimens all told.

The tests were divided into three series with regard to age; viz., 30, 40 and 60 day specimens. One 6-in. and one 3-in. specimen were used for each test. The specimens were all tested under pressure by being clamped on to a cast iron head, through which the water was conducted by a $\frac{1}{2}$ -in. pipe, connected to an inlet pipe from the college pressure mains. The connection between the test piece and the cast-iron head was made water-tight by means of

a rubber gasket placed in a groove in the head. The pressure was read by a pressure-gage attached to the inlet pipe; the maximum pressure from the mains being about 60 lbs. per sq. in. The water was started at 30 lbs. per sq. in. and at the end of 6 hours was increased to 40 lbs. After 16 hours at 40 it was increased to 60 lbs. and this pressure was maintained from 7 to 22 hours in the initial tests. Nearly all of the specimens were broken open at the end of tests and the penetration of water, or moisture line, observed.

For the tension test briquettes of standard size were made and tested in a Fairbank Standard Testing machine. The briquettes were made along with the specimens for the pressure test, and from the same material. They were all stored in moist air for 24 hours and then put under water. The object of this test was to compare the strength of the different mixtures.

In the absorption tests the specimens were cubes 3x3x3 ins. made from the same mixtures as the pressure specimens. They were allowed to set in dry air for one week, then weighed and stored under water for 90 days. They were then removed, wiped dry, and reweighed and the percentage of absorption determined.

In the pressure test no measurement of the water passing the material in the 30 day test was made, but in the 40 and 60 day specimens and all special tests, the water was caught in pans and measured. In the initial tests the rate of drip per hour was noted while in the special tests the total amount was measured. The tops of all specimens in the pressure test were kept filled with water to prevent any tendency of the material to shrink away from the forms. In fastening the specimens on the testing apparatus the water was allowed to force out the air in the top of the form before the final clamping to the rubber gasket, as it was noticed that otherwise the air confined between the pressure face of the specimen and the cast-iron head would be forced out through the concrete.

Mortars.—In the 1:2 mixtures of common cement the age of the specimen did not seem to have any effect on the permeability. The 30 day and 60 day specimens were reserved for special tests but the 40 day specimens were broken and found quite fully saturated. The special tests showed up well but when broken were also found badly saturated. The clay specimens improved slightly with age, but all except No. 35, in the initial and special tests were largely saturated. No. 35 was dry on the outer face during the entire test and passed no water, but was wet half way through when broken. As a whole the clay specimens were less impermeable than the specimens with common cement alone. The 1:2 mixtures of reground cement were much better than the clay or common cement mixtures. Age had no effect on the reground pieces as the 30 day specimens, Nos. 15 and 17, gave better results than any others. Neither of these leaked at all during the tests.

The 1:3 common cement mortars were all badly saturated in every case, when broken. The 10 per cent clay mixtures were badly wet and in most cases completely saturated when broken. Age seemed to have no effect on these mixtures. On an average these specimens were slightly better than the 1:3 common cement specimens. The 15 per cent clay mixtures as a whole were a failure. No. 45 was the only one that passed no water in the special tests but when broken it was found to be wet to within 2 inches of outer face. The reground 1:3 mixtures were all good examples of impermeability. Every specimen, when broken showed wetting in but slightly.

Concrete.—The 1:2:4 concrete mixtures with common cement either leaked badly or were found to be

completely saturated when broken. The 1:2:4, 15 per cent clay specimens, became more wet on the outside than those made of common cement. All specimens leaked badly and in almost every case were completely saturated when broken. The 1:2:4, 15 per cent specimens became wet on the outer face almost as soon as the pressure was applied and remained so during the entire test. All specimens were completely saturated when broken. The 1:2:4 reground cement specimens showed in every case but little penetration of water. No. 53 leaked quite badly at the beginning of the test but when broken it was found to be dry in the interior and showed that the leak was around the edge next to the form; evidently due to imperfect bond.

The 1:3:5 common cement specimens of this mixture all leaked badly and when broken were found completely saturated. The reground cement specimens of this mixture were all good and compared favorably with the 1:2:4 specimens with reground cement.

Remarks.—From the data secured, it will be noticed that leaking took place in a great many cases, while in some instances the amount of leak was nil. This was readily explained when the specimens were broken. The leak in some cases was next to the form, due to imperfect bond between the cement and iron, while in other cases the leak was through the edge of the material, apparently due to a less density here than in the center; in still other instances the water penetrated through the center as readily as through the edge. Taking into consideration the outward appearances during the test and the appearance of the interior when broken, there was little difficulty in drawing conclusions as to the permeability of the different mixtures.

It has been advocated in the use of clay as a waterproofing material, that it unites chemically with the other materials of the mortar or concrete, but in these tests the clay was washed out when the specimens were placed under pressure, showing that only a mechanical combination had been produced. All clay specimens when broken showed very poor bond; in some cases there was a noticeably honey-combed condition. In all these specimens, it was also noticed that leaking increased with time under pressure; in some cases becoming so great as to necessitate removal of the specimen. These conditions are readily explained if we consider the clay only mechanically combined. The clay in this case being an inert material, prevents perfect contact of the cement with the sand or stone.

Conclusions.—In conclusion, we would say that the mixtures, using common cement alone, were all failures from the standpoint of impermeability, except the 1:2 specimens, Nos. 7, 8, 10 and 12. These last while not leaking, were deeply penetrated by the water, rendering it unsafe to recommend them where impermeability is required.

The clay instead of making the specimen more impervious increased the permeability, as was shown by both the pressure and absorption tests. It is our belief, therefore, that sand should be free from clay to obtain the most impermeable mixture.

The specimens, in which reground cement was used, showed up well in all three tests. The different mixtures gave fairly uniform results and it was not difficult to see their superiority over those with common cement and clay.

From the results obtained, we would not hesitate in recommending any of the mixtures with reground cement in preference to those with clay or common cement. Not alone does reground cement make a better waterproofing material, but it also increases the strength, as was shown in the tensile tests. The fact that reground cement sets more quickly, will not, we

believe be a serious hindrance to its use. When used in mortar or concrete 20 to 30 minutes were required for it to set which would be ample time for good workmen to mix and place material.

*Condensed from Bulletin No. V, Iowa State College, Engineering Experiment Station, Ames, Iowa. By O. L. Huffman and E. S. Fowler.

THE EFFECT OF ELECTROLYSIS ON METAL EMBEDDED IN CONCRETE.*

Portland cement mortar and concrete form an excellent protecting cover for iron and steel under ordinary conditions, but when concrete has steel embedded in it under such conditions that there are electric currents passing through the steel and from the steel to the concrete, there is set up a corrosive action due to electrolysis that may rapidly deteriorate both the metal and the concrete.

The conditions which bring about this destructive action are neither uncommon nor complicated. If electric currents pass into dense concrete through steel which is tightly embedded in it, an action takes place which will in time disrupt the surrounding concrete. If the concrete is not dense, but contains an appreciable percentage of voids and is therefore somewhat compressible, as in the case of a cinder concrete, then the result of the swelling action may be that of closing up some of the voids and so no actual rupture of the mass may occur. If the steel but rests upon the surface of the concrete and is not embedded in it, the action may take place on the plane of contact without disrupting the concrete. The current passing may be extremely small, with the result that the action is very slow, but the effect is the same in the end.

It is not uncommon practice to embed the bases of steel building columns in concrete or the bases of elevated electric railway structures and bridge and trestle columns. In any of these cases there may be small stray electric currents passing from the metal to the surrounding concrete if electric currents are much used in the building or if electric railways pass over the bridges or trestles.

If the conditions are fulfilled—that is, if a portion of the steel is solidly embedded in dense concrete and if even small electric currents pass through the steel and leave it and enter the concrete where it is thus firmly embedded—it is only a matter of time until the concrete will crack and break away from the steel.

These facts have been well established. They have been previously studied, experiments demonstrating them carried out, and results reported in several technical publications during the past four years. Some of these investigators reported their work in the following publications: Mr. Maxmillian Tock, "Journal of American Electro-Chemical Society" for June, 1906; Mr. A. A. Knudson, in "Journal of American Institute of Electrical Engineers" for 1907; Mr. N. J. Nicholas, in "Engineering News", for Dec. 24, 1908, and Dec. 1, 1910; Mr. A. S. Sangsdorf, in "Journal of the Association of Engineering Societies", for February, 1909, and Mr. G. B. Shaffer, in "Engineering Record", for July 30, 1910.

Some further data bearing upon this destructive action is shown by a series of experiments conducted by Westinghouse, Church, Kerr & Co. and which are described as follows:

A series of steel plates about 1-16 in. thick, 2 ins. wide and 6 ins. long were embedded in concrete blocks. These plates had been previously painted with two full flowing coats of paints of various kinds. In each concrete block were placed 11 plates, 10 of which were painted and one uncoated. The purpose of painting the plates was to seek a proper protecting medium for steel exposed to these conditions, but "that is another story," and the results so far as they have to do with protective coatings will be reported at another time.

The concrete blocks were about 6x6x14 ins. They were made of dense concretes, using a mixture of samples of good brands of American Portland cement, and for the coarse aggregates crushed limestone, crushed granite, gravel and cinder. Two sets of blocks were made up. They were made of the same mixtures and in them were embedded plates coated with the same paints. The one difference in the treatment of the two sets of blocks was that a small electric current was passed through the plates in the one case and not in the other. In both cases the blocks were kept standing in a shallow metal pan of water to keep the concrete damp.

All the plates were connected in parallel to the source of the current and the direction of flow of the current was from the plates through the concrete to the metal pan. The voltage was maintained at about 10 by means of a lamp bank. The total current flowing was less than two-tenths of an ampere.

The first effect apparent on the blocks subjected to electrolysis was the appearance around the plates where they entered the concrete of small brown globules or bubbles, apparently of iron oxide. These may have been caused by the escape of small quantities of gas liberated by electrolytic action on the surface of the plate down in the concrete, which has traveled up along the plate, and, carrying iron oxide with it, has left a deposit of rust where the gas escaped on the surface.

This excrescence made its appearance after one to three weeks and gradually increased. Its amount seems to be proportionate to the amount of corrosion taking place on the plate about which it forms. Those plates which corroded very little showed no such excrescence as those which were badly affected.

The next noticeable effect was a very fine hair crack on the top of the concrete block, extending from one or both edges of the plate outward. Gradually this hair crack grew until it reached the sides of the block and finally the block split through completely. This bursting of the block has occurred only in cases where the corrosion has been very bad and has taken place at periods ranging from a week to three months or more after current was turned on. The tests were continued until the blocks began to crack and split. They were then broken open and the plates removed. These results took place only in the set of tests which were subjected to the electric current. The other set showed no change in appearance whatever on the outside of the concrete block. In these the plates were all free from rust or corrosion except at the point where they entered the concrete and where the metal was subjected both to the moisture of the concrete and to the air. Here and there appeared some slight rusting. The concrete was all sound and hard.

In the case of the blocks subjected to the electric current the corrosion of the metal was very marked and the plates were deeply pitted. The denser blocks were broken in many places, while the porous cinder concrete block was still sound and whole, although the corrosion of the metal was as marked as in the other cases.

Not all of the cracks were large enough to show in

a photograph, but they had developed at seven of the eleven plates. So far these experiments and results agree with those described in the articles mentioned above. But here the close resemblance ceases.

When the cracked blocks were broken apart the concrete was found to be hard and sound except immediately adjacent to the metal plates, where the concrete seemed slightly softer to a depth of perhaps 1-16 in. There was no appreciable spreading of iron rust along the fracture, which showed clean, fresh concrete, except for some discoloration extending very slight distances from the metal, $\frac{1}{8}$ in. or less.

As to the cause of this rupture of the concrete five different theories have been offered as follows: (1) Expansion of the metal due to change in its chemical nature; (2) hydrostatic pressure; (3) pressure of liberated gases; (4) internal heating and consequent expansion; (5) expansion of metal due to corrosion. It will be noted that only one of these theories, the last one, depends upon the presence of a metal. Each of the others would hold equally well if some non-metallic conductor were embedded in the concrete and a current passed.

In order to get further evidence as to which of these five explanations is the nearer correct, the following experiment was carried out:

Two 6-in. cubes of dense concrete were made up, in one of which was embedded a $\frac{1}{2}$ -in. round iron rod and in the other a $\frac{1}{2}$ -in. round carbon rod. Carbon was chosen because under the temperature and conditions it would not oxidize or swell appreciably, yet it would transmit current to the heart of the concrete block just as the iron rod would and offer little resistance. Electrolysis would take place on the surface of the iron, gas would be formed in the one case as in the other; in fact, the only important difference in the action between the carbon and the iron rods, for the purpose of this investigation, is the fact that the iron oxidizes or rusts under these conditions, while the carbon remains passive and unaffected. These two blocks were then connected up in parallel and a current passed through them. There was no rise in temperature which the hand could detect. A difference of potential of about 10 volts direct current was maintained on the two blocks. In just one week the block containing the iron rod burst and after a period of over two months the block containing the carbon rod was apparently as sound as ever. The voltage was then raised to 30 and two days after to 50 with no apparent effect.

In the light of these results the theories enumerated above may be examined to ascertain which of them seems most fully to explain the phenomena described. The first mentioned theory—namely: that the cracking is caused by the expansion of the concrete due to change in its chemical nature—is commented on by its advocate as follows:

Experiments * * * seemed to show that * * * the strong oxidizing agents, chlorine and oxygen, permeated the pores of the concrete and in the presence of water, changed some of the cement compounds to higher states of oxidation. Such a change should make more space necessary and so act as a bursting force.

This may be answered with the statement that with the carbon electrode the same gases would be liberated and the action of these gases upon the concrete should have burst as surely with the carbon rod as with the iron rod. The fact that this was not the result throws doubt upon this theory.

The second theory is that a hydrostatic pressure is produced at the anode, which ruptures the block. An advocate of this theory says:

According to the tests of Quincke * * * it appears that an actual bodily transfer of electrolyte takes place under the action of electric currents. * * * This transference caused a rise in hydrostatic pressure at the anode or cathode by heaping up the electrolyte, as it were.

If this were true when iron is used, there appears no reason why it should not be equally true when a carbon electrode is used, and a theory which does not explain this discrepancy is defective.

Of the third theory, which accounts for the cracking by the presence of a gas pressure at the anode, an exponent says:

The cracks in the concrete are best accounted for by the following theory of gaseous pressure. The steel pipe * * * liberated two gases at its surface, viz., oxygen and chlorine. If these gases were hindered in their escape by the surrounding concrete they would accumulate and gradually increase in pressure. As the pressure in a particular void increased the surrounding cement crystals would be subjected to a tensile stress * * * and might reasonably crack.

To this the same answer applies—namely: that the gases are liberated by the carbon rod as by the iron rod.

The next or fourth theory mentioned is to the effect that the current heats up the concrete internally and the consequent expansion bursts the block. Its sponsor says:

This leads to the belief that the indirect thermal effect of the current is a more important factor than the formation of gases under sufficient pressure to rupture the concrete * * * The temperature may be supposed to have risen considerably along the path, giving rise to local expansion, cracking and general disintegration.

As to the former theories, the reply again is that this heating by current is in no way peculiar to an iron electrode and therefore the block containing the carbon rod should burst as quickly as the one having the iron rod. Even the increase in voltage from 10 to 50, with the consequent increase in current passing, and in the heat generated, apparently had no effect on the block, though the iron burst its block in one week at 10 volts.

The fifth or last theory, which is the one most commonly advanced, seems to explain more completely the phenomena noted. We all know that iron rust occupies more volume than the original metal from which it was formed, and as the rust which formed on iron subjected to the conditions here described must find space for itself, a great internal pressure is set up as the amount of rust increases until the inclosing and confining concrete gives way. This great internal pressure also explains the partial breaking down, or crushing or softening of the layer of concrete immediately adjacent to the metal.

It is not only when a current is passing that steel corrodes when embedded in concrete. Reinforcing bars are sometimes placed so close to a surface that is exposed to the weather that air penetrates the concrete to the steel in dry weather and water reaches it in wet weather. Under these conditions the concrete does not possess sufficient protective power to overcome the corroding tendencies of steel which is alternately wet and dry. This becomes especially true after repeated rains have washed out a portion or all of the free lime in the outside layer of the concrete which so effectively protects iron and steel from corrosion. In outside walls the reinforcing steel should be kept far enough from the surface to be well protected. As an illustration of the failure that may follow the placing of steel too near the surface there may be mentioned

an exterior wall in which the steel in a few places was less than $\frac{1}{2}$ in. under the surface. The result was the corroding of the metal first at the points where the rods were nearest the surface and then the gradual extending of the corrosion along the rods, with the consequent bursting out of the concrete in which it was embedded. This building was erected about nine years ago and the rusting of the bars and cracking out of the concrete became apparent after some two or three years.

Similar effects have followed the use of ungalvanized metal lath over which insufficient coating of mortar had been placed. In some cases large areas have scaled from outside stucco walls because the rusting of the iron lath and the consequent swelling action separated the stucco on the outside of the lath from that on the inside. Having thus lost its bond the outside stucco falls off very easily. The painting of steel lath to protect it against such action we believe to be of little avail. The remedy lies in the use of a substantial well galvanized lath and placing on it a good and sufficiently heavy coating of dense plaster.

*A paper by Cloyd M. Chapman before the National Association of Cement Users.

A LARGE ORDER FOR ELEVATING AND CONVEYING MACHINERY.

The Webster M'f'g. Company of Chicago and Tiffin, Ohio, recently closed a contract with the Universal Portland Cement Company for the largest amount of elevating and conveying machinery that has been placed as one order in a number of years.

The order covers all of the elevating and conveying machinery for the Coal Grinding Building, Stock House and Burner Building of the Universal Plant No. 6, now under construction at Buffington, Ind. Some of the features of this installation will prove of interest to users of similar machinery.

Almost 600,000 pounds of steel plates, angles etc. will be required for the elevator casings and screw conveyor boxes. In the Stock House alone, are 16 lines of screw conveyor, each 128 ft. long, all encased in dustproof steel boxes. There will be 16 steel elevator casings also made dust-tight throughout, as well as several thousand feet of chain belting.

All of this material except the steel plates and shapes, including the malleable iron and steel buckets and chain will be made in the Webster plants. All of the steel work will be fabricated and assembled before shipping at the new plant of the Webster M'f'g. Co. at Tiffin, Ohio, which is doubtless the most modern and up-to-date plant for the manufacture of this class of machinery in the country.

All steel casings are dust-proof and parts subjected to wear are arranged so that the worn portions can be quickly removed and replaced.

When this plant is completed the Universal Portland Cement Company will have a daily capacity of 40,000 barrels of cement, and every barrel will be handled at some stage of production by Webster-made machinery.

This extensive plant and business, which has grown to such large proportions within the past seven years, has always been under the direct supervision of Mr. J. Berquist, Works Manager of the Universal Portland Cement Co., who, on account of the phenomenal success of this particular brand, is one of the best known men engaged in the manufacture of cement today.

Mr. A. G. Carlson is Mechanical Engineer for the company, and Mr. F. J. Robinson, Chief Draftsman.

DRY AND WET PAN GRINDING.

The American Clay Machinery Company, Willoughby, Ohio, are noting greater activity on the changing of the grinding and mixing departments of sand-lime-brick plants. At the recent meeting in Detroit there was considerable interest amongst the manufacturers in the dry and wet pan grinding, which has been very satisfactorily introduced in a number of plants. They are making a complete change in the plant of the Atlas Brick Company, El Paso, Tex., installing the combination of wet and dry grinding machinery, which is a more economical way for making of high class brick. They are also placing new grinding and mixing machinery in the plant of the Watertown Pressed Brick Company, Watertown, S. D., and have secured the order of the Manitoba Pressed Brick Co., of Winnipeg, Manitoba, for making the same kind of a change in their plant. The installation of the presses and mixing machinery at the Sioux Falls Pressed Brick Company, of Sioux Falls, S. D., are giving excellent results, as the owners of the plant are at the present time testifying. Mr. W. J. Carmichael, manager of the sand-lime-brick department of the American Clay Machinery Company, has given a number of years of careful study to the special needs of the sand-lime-brick manufacturer, and finds that the new system of grinding which has been developed in the last year or two is giving general satisfaction wherever it has been introduced.

NEW SAND-LIME-BRICK PLANT STARTED.

The Massachusetts Sand-Lime Brick Company, of Oxford, Mass., will soon have their plant in that city in full operation, turning out sand-lime brick. The plant will have a capacity of 20,000 brick per day on the single unit system. The plant is arranged so that this capacity can be doubled without overworking the machines. The plant is equipped with modern power furnishing machinery, two 250 H. P. boilers and one 150 H. P. engine having been installed. The proprietor, Mr. Ryan, was a visitor at the recent annual convention of sand-lime brick manufacturers, held at Detroit, Mich.

KOEHRING "MIXER."

"The Mixer" is the title of a little house organ issued by the Koehring Machine Company of Milwaukee. The reading matter of the issue consists, for the most part, of a series of short paragraphs, bright and to the point, a mixture of good sense and good nonsense. Each alternate page is devoted to an illustration of some feature of the Koehring shops, or of one of the Koehring machines. The book is worth having, both as an advertisement and also for the reading matter which it contains.

SHELBY COUNTY COURT HOUSE.

That sidewalk lights are practical indoors as well as out is demonstrated by the construction of the new court house of Shelby county, in Memphis, Tennessee, where the "Raydiant" sidewalk lights manufactured by the Berger Manufacturing Company, of Canton, O., are in use.

The lights were installed largely in the courts of the huge building, which is one of the handsomest and most magnificent in the South. The cost of the building was \$1,500,000. The architects for the court house were Hale & Rogers of New York. Perfect light is an essential in a county hall of justice and it was only after a thorough test and demonstration of the light giving qualities of the "Raydiant" system that the lights were contracted for.

"CHICAGO AA" AT THE FOURTH ANNUAL CEMENT SHOW.

Below is a photographic reproduction of the booth of the Chicago Portland Cement Co. which occupied 400 sq. ft. of floor space at the recent Cement Show. It consisted of an ornamental wall arrayed with urns of unique design and an artistic model fountain with running water. The Terrazzo Mosaic floor in two colors raised much favorable comment among the visitors at this booth. The furniture comprised benches, chairs, tables, mantel, pedestals and vases cast from Louis XVI models with "CHICAGO AA" Portland Cement.

each end. The gauge is then moved along the street and the excavation is made to the proper depth. No grading stakes are necessary and when the grading is completed the street has the proper grade and crown. This gauge can be used equally as well on single curb as on combined curb and gutters.

WESTINGHOUSE MOTORS FOR UNIVERSAL PLANT.

The Westinghouse Electric & Manufacturing Company has recently closed a contract with the Universal Portland Cement Company for motors to operate their



Booth of Chicago Portland Cement Co. at the Chicago Cement Show.

THE ROUGHEN STREET GAUGE.

Our readers' attention is hereby called to the illustration shown in the advertising part of this issue of a device known as the Roughen Street Gauge for giving a street a perfect crown and grade, put upon the market by P. Roughen, Fond du Lac, Wis., from whom full particulars may be obtained. It is simple in construction, being built of two planks, steel center mast and steel two-wheel trucks. The planks are attached in the center to the steel mast and on the ends to steel extensions at the wheel trucks. By means of these extensions any width of the street can be obtained. On each side of the planks are trestle rods that keep the gauge from swaying, and extending from the stop of the mast to the planks are two adjusting rods that are provided with locknuts to set and hold the gauge to the desired crown. Each end of the gauge is provided with a small hand-wheel by which the gauge may be raised or lowered between the trucks. The whole gauge is built strong throughout but nevertheless is light and is easily moved. The gauge can be adjusted to any crown of any width of street.

The gauge is used for grading the streets after the curb and gutter is built by placing the machine in position by resting the wheel trucks on the gutter and lowering the planks by means of the hand-wheels at

No. 6 Plant at Buffington, Indiana. The motors will be of the "MS" mill type, having characteristics specially suitable for cement mill work, and they will operate on a 3 phase, 25 cycle, 440 volt circuit. The sizes range from 5 hp to 200 hp, and the aggregate capacity is 11,500 hp. This plant will be the largest in the United States, having a daily capacity of approximately 12,000 barrels, and will be electrically operated throughout; the various drives being of the latest development for cement mill work.

NO AD IN THIS ISSUE.

Evidently the Cement Tile Mchy. Co., of Waterloo, Iowa, who are the makers of the popular Schenk Cement Drain Tile Machine, the Perfection Concrete Mixer, the Four-Way Block Machine and the complete line of S. & S. Concrete Machinery and Equipment have more work on hand than they are able to attend to for they advise us that they will send no copy for the March issue of this publication owing to the fact that time is too precious.

If the reader is interested in Concrete Machinery of any kind we suggest that he refer to the February issue of this paper, wait until the April issue or better still, write the Cement Tile Mchy. Co., for further particulars regarding the S. & S. line.

NEW CEMENT MILLS.

The annual stockholders meeting of the Choctaw Portland Cement Company was held at Hartshorne, Okla., recently. The company's plant is fast nearing completion. The following board of directors was elected at the meeting:—J. A. Henry, Altus, Okla., E. T. Kirk Maysville, Ky., F. W. Freeborn, Scarritt Bldg., Kansas City, Mo., J. B. Westbrook, Oklahoma City, Okla., E. H. Jayne, Edmond, Okla., and C. B. Blake, B. E. Allison, and N. E. Tuell, of Hartshorne, Mr. Allison is general manager and Mr. Blake president of the company.

The Exshaw Cement plant at Alberta has been purchased by the Canadian Cement merger for \$1,000,866, and the manufacture of cement will be continued.

It is reported that the Inland Portland Cement plant at Metaline, Wash., will be manufacturing cement by March 20.

W. J. Pennington of Burlington, Wash., is interested in the construction of a cement plant at New Westminster, B. C., where he has 1,400 acres of lime rock land.

Some time in March the million dollar Clinchfield Cement plant at Kingsport, Tenn., will go into operation giving employment to 300 men who will produce 1200 barrels of cement daily. This plant is owned by Mark Patter, a New York millionaire, and is the first of its kind to be established in this section of the south.

The Bellair Wall Plaster Co. has been incorporated at Bellaire, Ohio, with a capital of \$25,000 by R. S. Browary and others.

It is reported that A. A. Hammer of Pullman, Wash., representing Portland people who have been making investigations at Bossburg, Wash., has found requirements for the manufacture of portland cement and that they have taken options on a number of properties near that place. Should satisfactory freight rates be secured into that territory, a huge cement plant, costing in the neighborhood of \$500,000 will be established. The erection of a cement plant at that place would give employment to about 200 men during the coming spring and summer.

It is announced that the new cement plant at Toluca, Hidalgo, Mexico, is to be doubled in capacity. W. E. Burk, general manager of the company recently placed orders in the United States for machinery to increase the capacity of the plant to 200 tons of cement daily. This company has made a remarkable record of success. The plant's construction was begun in September 1909, and was only finished a few months ago.

Announcement is made that financial arrangements have been completed to finish the mammoth plant of the Atlantic Portland Cement Company, at Stockerton, Pa. The company was organized several years ago by I. A. Bachman and, with the exception of himself, consisted entirely of California capitalists. Losses sustained in the San Francisco earthquake halted the completion of the plant by these men. Capital stock is \$5,000,000.

The Fort Dodge Portland Cement Corporation has its plant at Gilmore City, Iowa, now under construction, and will push it through to completion as rapidly as possible.

The plant will have a capacity of 5,000 barrels of "Ft. Dodge" brand daily, this output being made possible by the installation of ten kilns, 8x125 feet. The plant is being constructed by the Gilmore City Construction Company, with C. McLaughlin, of 215 Reliance Building, Kansas City, Mo., as engineer.

The company is capitalized at \$3,500,000, and has its general officers at Fort Dodge, Iowa.

The officers areas follows:

PECK CARRIER

THE STANDARD MACHINE FOR HANDLING

Cement, Crushed Rock, Hot and Cold Clinker, Coal, Etc.



One of five PECK CARRIERS at the Sandusky Portland Cement Works, Dixon, Ill., to handle clinker, coal and rock. View shows horizontal run with bucket tilted for emptying into bin.

Send for our book—the **Peck Carrier**; the proper method of conveying is explained supplemented by graphic diagrams and detail illustrations.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

NEW YORK, PITTSBURGH, ST. LOUIS,
299 Broadway. 1501-2 Park Bldg. Central Nat'l Bank Bldg.

SEATTLE, DENVER,
439-440 N. Y. Block. Lindrooth, Shubart & Co.

NEW ORLEANS,
Wilmot Machinery Co.

SAN FRANCISCO—Eby Machinery Co.

President—F. D. Brandenburg.

Vice-President—R. H. Van Alstine, M. J. Nicholson.

General Manager—T. A. Mair.

Secretary and Treasurer—H. S. Van Alstine.

A little booklet from the Cape Girardeau Portland Cement Company, Cape Girardeau, Mo., announces that this company has now completed its plant and has it in operation. The booklet was gotten out in the early part of November, and announced that by November 15 the company would be prepared to make shipments of its Eagle Brand Portland Cement.

The Commercial Club of Menominee, Mich., announces that it has secured the location for the new cement mill for the Empire Portland Cement Company of Portsmouth, Ohio, a \$2,500,000 corporation. The city gives the company a site of twelve acres. For that consideration the company will erect a plant to cost \$500,000 and employ 200 men. Raw material will come from Sturgeon Bay, where the company owns deposits of marl and rock.

A large deposit of gypsum in the state of Nevada has been purchased by James H. Jones of Reno. It is 10 miles southwest of the city of Gerlach and a plant will be erected at once. A railroad will be built from Gerlach to the deposit.

The Gypsoil Co., Citizens National Bank Bldg., Los Angeles, Calif., has a large deposit of gypsite, a rare occurrence of gypsum, on a tract of 640 acres at Moapa, Nevada. The company is preparing to establish a plant with a capacity of 200 tons daily, for pulverizing the gypsite, as it is now being screened by hand, and they are shipping two carloads a day. Organization has just been effected by the Gypsoil Company and H. B. Guthrey elected president, R. J. Higgins, secretary and treasurer, and J. Bouse, general manager.

I. H. Hanes of Montrose, Colo., is going to Denver

to make arrangements with capitalists for the development of an immense deposit of gypsum near Montrose. Hanes located the deposit several months ago, but as it is several miles from the railroad the development work was impossible with his small capital. Experts say the deposit is 90 p. c. gypsum. Thousands of tons are in sight.

It is reported that Frank Peckenpaugh will erect a cement plant at Logan, Iowa, in the near future.

The Dakota Plaster Co., Rapid City, S. D., is contemplating the erection of a new mill, according to press reports.

MR. A. BICKEL.

Mr. A. Bickel formerly contract manager of the Freeborn Eng. & Const. Company has accepted the position of President of the Commercial Construction Company, principal offices, Kansas City, Mo.

The Commercial Construction Company is engaged in a general line of municipal and private construction work.

A GOOD TEST OF CONCRETE BUILDING BLOCKS.

No better test of cement building blocks been planned than that afforded by the fire in the Patapsco Oil and Grease Co's. warehouse in Baltimore. Filled with oil and grease, the most inflammable of materials, the building was a roaring furnace and, making the test still harder, water was thrown continually upon the white hot walls. When the walls had cooled down, they were found to be absolutely uninjured except by smoke, and in rebuilding will be used again.

No comment is needed. This is a strong testimonial to the cement block as a building material.

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CEMENT

... AND ...

ENGINEERING NEWS



THE COSHOCTON LIGHT & HEATING CO.'S HYDRAULIC PLANT

An interesting hydro-electric development has recently been completed at Roscoe, Ohio, by the Coshocton Light & Heating Co. The W. H. Scott Co., of Chicago, were the engineers, and Mr. W. E. Warne was their representative in charge.

An artificial canal parallels the river, taking water at a dam six miles up stream and bringing it to the power house shown in the illustration. Here Allis-Chalmers horizontal submerged turbines develop 1600 horse power at the normal head of 34 feet. The wheel chamber is at the right, appearing only as a blank wall, and the draft tube channel, molded in the concrete, opens out of this wall below the low water elevation. Separated from the wheel chamber by a watertight concrete bulkhead is the electric equipment. The controlling works are behind the wheel chamber.

It was necessary to change the direction of flow in the tailrace, but without causing eddies or disturbance in the water. This was accomplished by curving the tailrace walls as shown. The curved forms were very successfully made with one inch matched lumber bent on rigid timbers. The finished work is remarkably free from inequalities of surface.

CEMENT AND ENGINEERING NEWS

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Chicago, April 1911.

CONCRETE BLOCKS.

Owing to the literature published by Engineering Societies and Cement Manufacturers, concrete construction becomes safer from year to year. Accidents are less numerous now than about five years ago and the methods of designing and reinforcing concrete work are based upon a better knowledge of the union of steel and concrete than in former years.

At the same time, plain concrete work has been

particularly favored by the exhibition of samples of finished work, which has become an annual event in various parts of the country. The educational value of the cement shows, therefore, cannot be estimated too highly.

Thousands of visitors at these expositions are either engaged in the manufacture of concrete blocks and other plain concrete work or contemplate doing so in the future. They come from all parts of the country, see the splendid results achieved by the numerous manufacturers of block machines and study and compare the literature issued by them.

The reading matter published by the manufacturers of concrete mixers and concrete block machines has become so comprehensive in time that it constitutes a small library by itself. Moreover, most of these publications deal with the subject in an interesting and fascinating manner, freely admitting the frequent failures of former years, and give the minutest details of cost of labor and materials so that the prospective buyer and manufacturer cannot be misled, providing he makes sure that he can purchase the materials in his district at the figures included in the calculations.

The various ways of facing the blocks and the endeavors of recent years aiming at an artistic finish of the surface of the blocks by means of white cement or mixtures of white cement and various colored



improved so much that it seems to have hardly anything in common with the work done a decade ago.

Every one who has witnessed the rapid growth of the cement industry in this country and the bold attempts of the contractors in using concrete, frequently without possessing the slightest knowledge of the intrinsic properties of the material, remembers that even the simplest application of concrete, for instance the laying of sidewalks or the manufacture of concrete blocks, was quite commonly accompanied by dismal failure.

These early stages of experimenting fortunately are a thing of the past. There are a great number of experienced contractors in the field nowadays, and a voluminous literature exists dealing not only with reinforced concrete construction, but likewise with all the details of plain concrete work.

This latter branch of construction has been par-

ground or crushed minerals, as for instance mica, hornblende, marble and so on, add another interesting chapter to the literature on the subject.

It would be needless to dwell at any length upon the fact that also the concrete block manufacturer has taken steps to waterproof his material in the same way as any other user of concrete and that his literature deals with the subject profusely.

Blocks and ornaments of the greatest variety can be obtained with the moulds and tools accompanying the machines, so that the powerful modern block machines and the illustrations and object lessons given gratis by the manufacturer enable the prospective concrete block manufacturer nowadays to turn out a product which differs widely from the block or ornament of former years in density and strength as well as in its waterproofing qualities and artistic effects.

SAND-LIME PRODUCTS.

By E. Leduc & Ch. de la Roche.

The following paper is a translation of a part of the famous French book, "Le Silico-Calcaire," written by the editors of the magazine "Revue des Matériaux de Construction et de Travaux Publics." It comprises a long series of tests which constitute the first comprehensive research into the apparently simple subject of mixing sand and hydrated lime with the final object of subjecting the mixture to high-pressure steam and manufacturing sand-lime brick or ornamental sand-lime products of any description.

The careful reader will see from the numerous tests, that a slight deviation in the chemical composition of the lime and in the physical properties of the sand leads to widely varying results. This will convince him that the process of manufacture of sand-lime products is not as simple as most people believe and that a thorough study of the underlying principles is required in order to assure success. The many tables accompanying the publication, furthermore, illustrate, better than a lengthy description, why so many manufacturers obtain only products of medium strength, for instance sand-lime brick that crumble to pieces if exposed to rainy weather, or brick which cannot withstand handling and arrive on the premises with corners and edges broken off.

Every chapter of this publication is brimful of information to the attentive reader who learns from it how to make accurate tests and who, if properly educated in time, will realize that the manufacture of sand-lime products cannot be carried on in a haphazard way as done mostly so far, but that daily tests of the raw mixture entering the brick press and of the finished product leaving the hardening cylinder are required in order to obtain uniformly good results and are just as necessary as the testing of the unburnt and calcined materials at a cement plant.

Introduction.

In 1880, Dr. W. Michaelis, Sr., of Berlin, Germany, took out the following patent covering the manufacture of artificial sandstone.

Description of Process: I thoroughly mix sand or any other modification or combination of silica with from 10% to 40% of hydrated lime in a suitable machine, mould the mass thus obtained and then subject it to the action of steam under high-pressure at a temperature between 100 and 300 centigrade in an apparatus of proper design. After several hours the mass is transformed into calcium hydro-silicate, which is as hard as stone and resists all atmospheric changes as well as the action of water.

Patent Claim: Process for obtaining artificial sandstone by letting high-pressure steam act upon a mixture of hydrated lime and sand or siliceous minerals at temperature between 100 and 300 centigrade in an apparatus of special design.

Most likely, Michaelis started out from the experience made by John, who showed that quartz, that is to say silica, was not attacked by lime under ordinary atmospheric conditions, and rightly concluded from this that a higher temperature and higher pressure might produce a conglomerate mass of great resistance through the formation of a silicate which would act as cement between the sand grains.

The outcome of his experiments proved his conclusions to be correct.

However, as the inventor did not succeed in interesting capitalists in his process and as the manufacture of high-pressure boilers was still in its infancy at the

time of the invention, Michaelis suffered his patent to expire. Only about 10 years later, the experiments were taken up again and led to the manufacture of sand-lime brick, which in time developed into a large industry.

The sand-lime brick industry has grown especially rapidly in Germany. While in 1900 only a small number of factories were in existence, they number at present 250, most of them being located in the neighborhood of Berlin, with a production of a billion brick per annum. This figure, though very large, represents but a small fraction of the 26 billion clay brick consumed annually, which are turned out by 11,000 clay brick factories.

Outside of Germany sand-lime brick factories are to be found in England, Switzerland, Italy and especially in the Netherlands and the United States of America, where the new product is in great favor nowadays.

Holland possesses about 30 factories and the United States approximately a hundred. In the latter country, about 60 manufacturers have formed an association for the furthering of their common interests.

Previous Researches: John demonstrated (in 1819) that a piece of quartz imbedded in lime-paste was not affected in the least even after a year.

More recently, Cramer analyzed a sand-lime mortar which was several centuries old and found only a trace of soluble silica which originated more likely from the lime employed in its manufacture than from the action of the lime upon the silica.

While under these conditions hydrated lime and silica do not combine, the opposite is true, if steam, heat and pressure are resorted to.

In 1904, Glasenapp carried on some experiments with sand-lime mixtures, which he summed up as follows: At a pressure of 10 atmospheres, 8 times more soluble silica was formed than at 5 atmospheres, if a rather coarse sand was used; however, in the case of a fine sand only $2\frac{1}{2}$ to 3 times as much. A mixture consisting of 90 parts by weight of sand and 10 parts of hydrated lime yielded, after an exposure of 8 hours to steam of 5 atmospheres, 3.06% soluble silica, and, to steam of 10 atmospheres, 7.58%.

If, instead of high-pressure steam, steam of atmospheric pressure was used (100 centigrade), he found, after 3 and 6 days, 0.47% soluble silica in the case of coarse sand and 0.92% for fine sand, whereas 3.33% and 7.58% of soluble silica were found after 8 hours, if high-pressure steam of 10 times the atmospheric pressure was used.

As Glasenapp's experiments were rather incomplete, we took up the subject once more and endeavored to determine the ratio of the combined silica to the size of the sand grains and to the pressure employed.

The Amount of Silica Going Into Combination Depends Upon the Fineness of the Sand and Upon the Steam Pressure.

We employed for our experiments two kinds of sand of three different grades of fineness:

Sand No. 1: Sea sand from Leucate passing a sieve with 8 meshes to the lineal inch and being retained on a sieve with 10 meshes.

Sand No. 2: Sand from Fontainebleau passing a sieve with 45 meshes to the lineal inch and being retained on a 180-mesh sieve.

Sand No. 3. Sand from Fontainebleau passing a sieve with 180 meshes to the lineal inch.

TABLE I.

No.	Sand	Steam Pressure	Time of Exposure to Steam	Mixture.		Soluble Silica in percent
				Sand	Lime	
1	1	15 lbs*	48 hours	90%	10%	1.196
2	1	15 "	1 week	"	"	1.410
3	1	120 "	8 hours	"	"	1.778
4	2	15 "	48 hours	"	"	0.696
5	2	15 "	1 week	"	"	1.418
6	2	120 "	8 hours	"	"	6.136
7	3	15 "	48 hours	"	"	3.320
8	3	15 "	1 week	"	"	6.244
9	3	120 "	8 hours	"	"	8.452
10	3	15 "	48 hours	50%	50%	3.660
11	3	15 "	1 week	"	"	6.414
12	3	120 "	8 hours	"	"	17.114

* 15 lbs. equals atmospheric pressure, that is to say steam at 100 centigrade or 212 Fahrenheit.

TABLE II.

Mixture subjected to pressure in lbs per sq. in.	Steam Pressure in lbs	Time of Exposure to Steam in hours	Soluble Silica in percent	Mixture subjected to pressure in lbs per sq. in.	Steam pressure in lbs	Time of Exposure to Steam in hours	Soluble Silica in percent
3.750	60	4	2.17	3.750	120	4	3.95
7.500	"	"	2.31	7.500	"	"	5.60
11.250	"	"	2.66	11.250	"	"	5.06
15.000	"	"	2.90	15.000	"	"	6.26
3.750	60	6	2.54	3.750	120	6	5.68
7.500	"	"	2.41	7.500	"	"	5.61
11.250	"	"	2.86	11.250	"	"	6.89
15.000	"	"	2.27	15.000	"	"	6.25
3.750	60	8	2.50	3.750	120	8	5.23
7.500	"	"	2.62	7.500	"	"	5.75
11.250	"	"	2.99	11.250	"	"	6.36
15.000	"	"	2.80	15.000	"	"	7.23
3.750	60	10	2.84	3.750	120	10	5.69
7.500	"	"	3.00	7.500	"	"	7.59
11.250	"	"	3.06	11.250	"	"	8.65
15.000	"	"	3.60	15.000	"	"	9.41
3.750	90	4	2.50	3.750	150	4	4.93
7.500	"	"	2.55	7.500	"	"	5.30
11.250	"	"	2.80	11.250	"	"	5.24
15.000	"	"	2.99	15.000	"	"	6.07
3.750	90	6	3.29	3.750	150	6	8.09
7.500	"	"	3.25	7.500	"	"	8.59
11.250	"	"	3.80	11.250	"	"	8.60
15.000	"	"	4.05	15.000	"	"	9.12
3.750	90	8	4.26	3.750	150	8	8.48
7.500	"	"	4.47	7.500	"	"	8.36
11.250	"	"	5.26	11.250	"	"	9.35
15.000	"	"	4.87	15.000	"	"	11.29
3.750	90	10	4.67	3.750	150	10	8.51
7.500	"	"	6.21	7.500	"	"	8.60
11.250	"	"	6.51	11.250	"	"	9.41
15.000	"	"	6.59	15.000	"	"	12.01

From these sands different sand-lime mixtures were prepared which contained, as indicated by table I, 10% and 50% by weight of a fat lime. The sand-lime mixtures were subjected to a pressure of 7500 lbs. per sq. in. and then exposed to the steam.

For the determination of the percentage of the various elements in question fragments of the hardened products were used that had been kept for more than a month in a dessicator containing concentrated sulphuric acid. As "soluble silica" or silica in combination with lime was regarded that part of the silica which, upon precipitation and evaporation with hydrochloric acid, went into solution if boiled for 6 hours in a 10% solution of sodium carbonate.

Table 1 shows that steam of atmospheric pressure (15 lbs.) produces even after 48 hours very little calcium silicate in the case of the sands No. 1 and No. 2. However, with the fine sand No. 3, passing a 180-mesh sieve, the action of the hydrated lime upon the silica is much more pronounced.

Sand No. 1 and No. 2 show very little gain in soluble silica from 48 hours to 1 week, namely, 1.41% against 1.19%, and 1.41% against 0.69%. The fine sand No. 3, however, shows a remarkable increase during this time, namely, from 3.32% to 6.24%, which plainly indicates that the action of the hydrated lime is the stronger the finer the sand, which has to be expected, of course.

TABLE III.

Relation Between Steam Pressure and Soluble Silica.

Steam Pressure in Pounds per Square Inch:			
60	90	120	150
Amount of Soluble Silica found after hardening.			
2.17	2.50	3.95	4.93
2.31	2.55	5.60	5.30
2.66	2.80	5.06	5.24
2.90	2.99	6.26	6.07
2.54	3.29	5.68	8.09
2.41	3.25	5.61	8.59
2.86	3.80	6.89	8.60
2.27	4.05	6.25	9.12
2.50	4.26	5.23	8.48
2.62	4.47	5.75	8.36
2.99	5.26	6.36	9.35
2.80	4.87	7.23	11.29
2.84	4.67	5.69	8.51
3.00	6.21	7.59	8.60
3.06	6.51	8.65	9.41
3.60	6.59	9.41	12.01
Average: 2.72	4.25	6.38	8.24

The soluble silica found in test piece No. 4, namely 0.696%, resulting from sand No. 2, seems to contradict the latter statement, if compared with test piece No. 1, which contained 1.196% of soluble silica and was made with a coarser sand. However, sand No. 1 and 2 were of a different nature. Therefore, the result of No. 4 must not be compared with that of No. 1, but with No. 7, because 4 and 7 were made with the same kind of sand, but of different grades of fineness. Hence 0.696% of soluble silica in opposition to 3.320% are the results obtained with different grades of fineness of the same sand from Fontainebleau.

Further tests with the two kinds of sand, from Leucate and Fontainebleau, have likewise proven that the sand from Leucate is more easily acted upon by the hydrated lime under the same conditions.

The effect of the fineness of the sand can best be seen at the test pieces subjected to high pressure (120 lbs) which yield considerably larger amounts of soluble silica.

TABLE IV.
Relation Between Duration of Steam Pressure and Soluble Silica

Duration of Steam Pressure In Hours.			
4	6	8	10
Amount of Soluble Silica found after hardening.			
2.17	2.54	2.50	2.84
2.31	2.41	2.62	3.00
2.66	2.86	2.99	3.06
2.90	2.27	2.80	3.60
2.50	3.29	4.26	4.67
2.55	3.25	4.47	6.21
2.80	3.80	5.26	6.51
2.99	4.05	4.87	6.59
3.95	5.68	5.23	5.69
5.60	5.61	5.75	7.59
5.06	6.89	6.36	8.65
6.26	6.25	7.23	9.46
4.93	8.09	8.48	8.51
5.30	8.59	8.36	8.60
5.24	8.60	9.35	9.41
6.07	9.12	11.29	12.01
Average: 3.94	5.20	5.73	6.65

The action of steam of 120 lbs. pressure is very plain in the case of sand No. 2, namely 6.13% of soluble silica as against 1.41% and 0.69% after a week and after 48 hours under atmospheric pressure. But, in the case of the coarse sand No. 1, the formation of calcium silicate is about the same after 8 hours under high pressure as in the presence of steam of ordinary pressure after 48 hours or a week.

Finally, experiments 10, 11 and 12 show plainly that the amount of calcium silicate produced depends likewise upon the percentage of hydrated lime contained in the sand-lime mixture, if it is subjected to high pressure, but that an increase of hydrated lime is of no avail, if the mixture is subjected merely to steam under atmospheric conditions (15 lbs. or 212 Fahrenheit); in the latter event, both mixtures, with 10% and 50% of hydrated lime, gave the same results.

In addition to the experiments described in the foregoing, which demonstrated the influence of the steam pressure and of the duration of the pressure upon the percentage of soluble silica formed, we have brought out the relation between them by weighing and tabulating the soluble silica or combined silica contained in the test pieces to be more fully described in table XXIV.

TABLE V.

Relation Between Initial Compression of Mixture and Soluble Silica.

Pressure to which Sand-Lime Mixture was subjected in lbs. per sq. in.

3.750	7.500	11.250	15.000
Amount of Soluble Silica found after hardening.			
2.17	2.31	2.66	2.90
2.54	2.41	2.86	2.27
2.50	2.62	2.99	2.80
2.84	3.00	3.06	3.60
2.50	2.55	2.80	2.99
3.29	3.25	3.80	4.05
4.26	4.47	5.26	4.87
4.67	6.21	6.51	6.59
3.95	5.60	5.06	6.26
5.68	5.61	6.89	6.25
5.23	5.75	6.36	7.23
5.69	7.59	8.65	9.41
4.93	5.30	5.24	6.07
8.09	8.59	8.60	9.12
8.48	8.36	9.35	11.25
8.51	8.60	9.41	12.01
Average: 4.70	5.14	5.59	6.10

The amounts of soluble silica recorded show likewise the influence of the initial pressure to which the sand-lime mixture was subjected.

The results are given in table II:

If we classify the figures recorded in table II according to the different steam pressure employed and if we take the average of all figures obtained for soluble silica at 60 lbs. of pressure, then at 90, 120 and finally at 150 lbs., as tabulated on table III, we see at a glance that the amount of soluble silica is the larger the higher the steam pressure is, namely:

2.72%	of soluble silica at	60 lbs. pressure
4.25%	" " " " 90 " "	
6.38%	" " " " 120 " "	
8.24%	" " " " 150 " "	

We obtain the same result, if we tabulate the percentages of soluble silica according to the time of exposure of the test pieces to the steam (see table IV), or according to the initial pressure to which the sand-lime mixture was subjected (see table V).

Classification after time of exposure to steam pressure yields the following average values for soluble silica:

Composition of the Calcium Silicate.

As the experiments made with a view to determining the chemical formula of the silicate formed during the hardening were incomplete, we took up this subject again and manufactured test pieces of sand-lime mixtures with sand passing the 180-mesh sieve and hardened them under varying conditions.

At the end of the experiments, we determined the total amount of lime, the uncombined lime (with sugar solution), the lime combined with carbonic acid (by determining the carbonic acid) and finally the combined silica (by boiling for 6 hours of the total amount of silica, precipitated with hydrochloric acid, in a 10% solution of sodium carbonate to which a drop of potassium hydrate was added).

A sand-lime mixture hardened for 6 hours at 150 lbs. steam pressure gave the following results:

Soluble Silica	19.81%
Lime, total amount.....	30.79 "
Carbonic Acid	33.87 "
Lime combined with Carbonic Acid.....	4.31 "
Lime, soluble in sugar solution.....	3.35 "
Lime, combined with silica, as difference.....	23.13 "

TABLE VI.

RELATION BETWEEN QUANTITY OF LIME, STEAM PRESSURE AND SOLUBLE SILICA.

Composition of Mixtures:		50 parts of Lime 50 " " Sand from Fontaine-bleau.				112.5 parts of Lime 37.5 parts of Sand		99 parts of Lime 49.5 " " Sand	
		1	2	3	4	5	6	7	8
Duration of Hardening Process and Steam Pressure:		3 h. at 120 lbs plus 3 h. at 240 lbs	8 h. at 120 plus 6 h. at 315	8 h. at 120 plus 6 h. at 390	8 h. at 120 plus 6 h. at 200	8 h. at 120	8 h. at 120 plus 7 h. at 460	8 h. at 120	8 h. at 120 plus 7 h. at 460
Soluble Silica.....		31.20	34.79	36.01	38.20	20.73	32.15	26.08	50.38
Lime, total amount.....		34.41	34.60	35.11	35.28	52.08	54.52	44.70	48.52
Lime, soluble in sugar solution.....		1.90	0.75	0.50	0.60	25.10	15.00	14.50	1.50
Carbonic Acid.....		3.15	3.83	5.04	3.42	7.56	5.68	6.43	4.83
Lime, combined with Carbonic Acid.....		4.00	4.87	6.41	4.35	9.61	7.23	8.18	6.14
Lime, comb with silica (as difference)		28.51	28.98	28.20	30.33	17.37	32.31	22.02	40.88
Formula of Silicate	Lime .....1.04	1.00	1.16	1.20	1.28	0.63	1.07	0.87	1.67
	or Silica .....1.02		or 1.04	or 1.01	or 1.08	or 0.62	or 1.15	or 0.79	or 1.46
			0.89	0.84	0.85	0.89	1.07	0.90	0.87

After 4 hours	3.94%	of soluble silica
" 6 "	5.20%	" " "
" 8 "	5.70%	" " "
" 10 "	6.65%	" " "

Finally, if the figures are arranged according to the initial pressure to which the mixture was subjected, the result is as follows:

For 3,750 lbs. of pressure	4.70%	of soluble silica
" 7,500 " " "	5.14%	" " "
" 11,250 " " "	5.59%	" " "
" 15,000 " " "	6.10%	" " "

Hence, the amount of calcium silicate formed depends upon the initial pressure to which the sand-lime mixture is subjected in being moulded, upon the steam pressure during the hardening process and upon the duration of the latter.

or, after dividing silica and lime by their molecular weights:

Silica	0.66
Lime	0.82
or	
Silica	1.00
Lime	1.24

which would answer the formula 1.25CaO, SiO₂ or 5CaO, 4SiO₂.

As this was the result of a single experiment, we repeated the tests and altered the conditions under which the mixtures were hardened.

In the same way as in the foregoing experiment, the mixtures were made with fat lime and pulverized quartz passing a sieve with 180 meshes to the lineal inch.

The various mixtures were moulded under a pressure of 7,500 lbs. per sq. in., then hardened for 8 hours at a steam pressure of 120 lbs. in order to give them a sufficiently high strength to allow of sawing them; at last small test pieces were cut out of the various cylinders and these were enclosed in sealed glass tubes containing water.

The tubes were placed in an autoclave and heated to different temperatures, hence subjected to different steam pressure as recorded in table VI.

The result is that increased steam pressure leads to an increase in the percentage of soluble silica (silica combined with lime to calcium silicate); hence the ratio of the combined silica to the lime must be considered as invariable.

Experiment 5, 6, 7 and 8 demonstrate that this assumption is correct, even if the amount of lime varies within wide limits, as in experiment No. 5 the amount of uncombined lime (that soluble in sugar solution) is 25.10%, whereas it is only 1.50% in experiment No. 8.

These experiments show that a hydrated calcium silicate higher in lime than the mono-calcium silicate does not exist, as the molecular ratio of lime to silica is in every instance about 1:1.

From this follows that the composition of the calcium silicate answers the formula CaO, SiO_2 .

Experiments.

From the foregoing chapters follows that the manufacture of artificial sandstone, sand-lime brick or sand-lime blocks comprises merely the moulding of a mixture of sand and hydrated lime and the exposure of the moulded piece to high-pressure steam.

As simple as this process appears to be, there are many factors to be considered in the manufacture of sand-lime products. In addition to the various items above mentioned, as fineness of the sand, initial compression of the mixture, steam pressure and duration of the hardening process, a number of other points have to be taken into account, as for instance, the nature of the sand, the chemical and physical properties of the lime and the more or less careful preparation of the mixture. With a view to ascertaining the consequences of each of these factors separately, we carried on the following series of researches which we may classify according to the different points of view considered, as follows:

The Nature of the Sand:

Siliceous sand.

Argillaceous sand.

Calcareous sand.

The Properties of the Lime:

Fat lime.

Hydraulic lime.

Quantity of lime contained in the mixture.

Fineness of the lime.

Lime, partly carbonated.

Various other Factors:

Initial compression of the sand-lime mixture.

Steam pressure.

Duration of hardening process.

Mixing of sand and lime.

Effect of drying-out of mixture before hardening.

Grinding of mixture.

Aging of hardening sand-lime product.

Effect of Admixtures:

Finely ground sand.

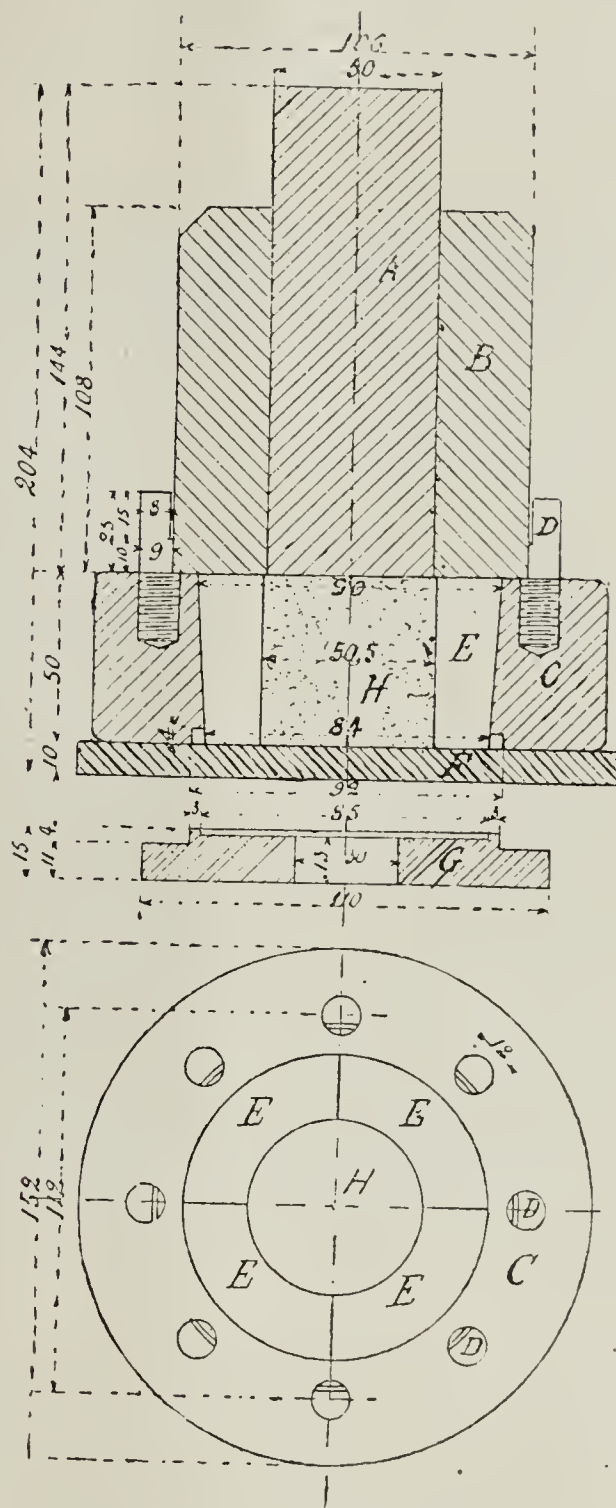
Puzzuolana.

Powdered glass.

Description of Experiments. All test pieces have been made with sand from Fontainebleau.

It was our aim to study carefully the effect of sand composed of grains of different size for the purpose of ascertaining, if the rules established for cement mortars of different density produced with graded and ungraded sand were applicable also to sand-line products, which latter were in fact compressed mortars. Unfortunately, however, the large grains of sand affected the mould to such a degree that this part of our research work had to be abandoned.

The mixtures of sand and lime were made by weight, then trowelled on a marble slab and moulded into cylinders 2 in. high and of equal diameter, so that the sectional area amounted to about 3 sq. in.



The mould (see cut) consisted of a forged ring C, into which the four segments E of a cylinder could be driven; this cylinder was slightly slanting on the outside, so that it could be removed without difficulty.

After the four segments were inserted in the forged ring C, a large hollow cylinder B was placed on the top of it, into which a sufficient amount of the sandlime mixture was filled to yield a perfect test cylinder.

In order to obtain a cylinder of equal height and diameter, it was necessary in every instance to determine, by a few preliminary tests, the accurate quantity needed of each mixture. After the weight was once determined, exactly the same amount was taken for each following cylinder of equal composition. The weight of the test cylinders differed, of course, ac-

cording to the conditions under which the experiments were made.

Now, the piston A was introduced into the hollow cylinder B and the whole apparatus placed on the table of a hydraulic press by which the sand-lime mixture was compressed at the desired pressure.

Upon being moulded, the test cylinder was taken out by removing piston A and cylinder B, by turning the ring C over and allowing it to rest on the screws D, and by forcing the four segments E out of the ring by means of the round plate G. In this manner, the steel segments and test cylinder could easily be taken out and dropped on an underlying rubber disc. All that remained to do was to carefully remove the four steel segments surrounding the test piece.

In order to prevent the test cylinders from drying out, they were put immediately into preserve glasses. The next day they were placed into an autoclave heated by gas which was tested for 270 lbs. of pressure (18 atmospheres).

According to the length of time required for their hardening, the test pieces were taken out of the autoclave either the same day or the following day, whereupon their resistance to compression was determined at once by means of an Amsler-Laffon hydraulic press.

This simple description of moulding and hardening the test pieces will show the reader how much time and what precautions were required for the manufacture and testing of a single set of cylinders.

(To be continued.)

THE IMPORTANCE AND COST OF CEMENT TESTING.

By Mr. W. Purves Taylor.

Although the importance of testing is generally recognized by the large consumers of cement, especially those engaged in constructing public works, its value, even to the present time, is not always apparent to the consumer of smaller quantities. It must be remembered that cement is an artificial product made by mixing certain ingredients and then treating the mixture in a complex mechanical process, so that, even if the greatest care is exercised, as it is in the best plants, certain variations in quality must necessarily exist. The ingredients are not by any means constant in composition, and hence both the proportions of the mixture and the treatment of manufacture must be continually changing. It is accordingly unreasonable to expect that any cement should invariably be uniform in its qualities and properties. The older plants have a certain advantage of experience over the newer ones, but, even in these, occasional batches of inferior cement are produced and allowed to get on the market. In the writer's laboratory all the wellknown eastern brands of cement are constantly being tested, and no one of them has escaped occasional rejections.

Reliable manufacturers generally take every precaution to prevent defective cement from leaving the mill, and make most careful tests to that end, but these tests are subject first to possible laboratory errors of sampling and manipulation and secondly do not and cannot take into account the alteration in its properties that the cement undergoes under certain conditions after leaving the mill. These variations and irregularities in the cement unavoidable in manufacture and not always discovered by mill tests, and which may be vital to the integrity of the finished structure, show the importance and the necessity for cement testing.

It is often argued that while testing is necessary for larger engineering works it is not as necessary for the smaller consumers,—those erecting small buildings, making concrete blocks, or laying sidewalks,—while, as a matter of fact, it is especially important in these cases, for if there is any particular difference in the quality of the material at the mill, it may be taken for granted that the poorer cement will be sold where it will not be tested. Even the cement rejected on the large works is generally sold to a dealer or small consumer. The trouble and cost of testing may at first make it seem almost prohibitive, but after a user of cement has begun testing and has found the freedom it gives from trouble on the work, and has felt the assurance that all his structures are safe and permanent, he realizes its value and invariably continues it.

The fact that poor concrete may be made from the best cement by reason of the use of an indifferent quality of aggregate or by careless mixing and placing, is no argument against testing cement, but rather one for it, because careful inspection during construction will readily detect and correct these conditions but no field inspection can prevent the use of inferior cement. A user of cement who desires the best quality of materials must therefore depend upon laboratory tests.

At the present time, however, it is almost unnecessary to advocate cement testing, for its importance has become so generally recognized that all important works regard it as an essential accompaniment to concrete work. The vast amount of cement now used requiring tests and the ensuing competition for decreased cost in testing has led, however, to an unfortunate condition in the testing itself.

Cement testing is a difficult process requiring experience, care, precision and knowledge, and hence should only be entrusted to well qualified men, but only too often this important work is relegated to utterly untrained and careless operators and the results obtained by such methods are really worse than nothing, as they often are positively misleading. Many tests made at the present time by supposedly responsible parties are ridiculous in their inaccuracy, as any one having knowledge of this subject will admit.

Instances of this might be cited without number. In one case a cement was rejected as being quick setting, but an investigation showed that the test had been made in a hot room in a temperature of over 80 degrees and the specimen, besides, placed directly over a radiator—the cement itself was entirely normal. Strength tests are often made by inexperienced boys committing every possible error of manipulation. In one case a cement reported as breaking at 125 pounds was found to give a strength of over 250 pounds when accurately tested. Cases of unjust rejection on the accelerated test for soundness through improper manipulation and interpretation of the results are by no means uncommon. Of the sieves used for testing fineness, not one in four has been properly standardized.

These inaccuracies, it must be remembered, are not only found in the small laboratories, but only too often in those of some reputation, and the cause may be found to be entirely due to the desire to cheapen the cost.

It should be recognized at once that if cement tests are made it is worth while to make them well, even at possibly a somewhat increased expense. A properly made cement test complete is worth to any commercial laboratory from eight to ten dollars a sample, with chemical testing at from a dollar and a half to two dollars per ingredient extra. Accurate appliances, experienced trained operators, and intelligent oversight

REMOVAL NOTICE.

After May 1st, 1911 the office of the Cement and Engineering News will be located at 1117 Schiller Building, Chicago, Illinois.

cannot be used if the cost is materially less, unless under exceptional conditions, and, without this accuracy in the work, tests have but little value. When a large laboratory is installed directly on the site of construction, testing many samples a day, with no charge for collecting the samples, and running at no profit, it may be possible to test cement for as low as from 1 to 2 cents a barrel, but for the ordinary concrete jobs it cannot be expected to cost much less than 4 or 5 cents a barrel.

To save time, trouble and some expense, it has become a frequent practice to test cement at the mill as it is packed in the cars. This is convenient as it does away with the trouble of sampling on the work and with the delay of waiting for the test, since the seven day tests may often be completed before the car arrives on the work. In spite of this convenience, however, the practice is not to be recommended on account of the alteration in its properties that the cement may undergo in the interval. This applies particularly to the time of setting. A cement may leave the mill slow-setting and arrive on the work very quick, due to temperature or atmospheric conditions. Even the strength may be altered considerably. Hence to be reliable the tests should be made only after the shipment is received on the work, even if more trouble is involved thereby. If an established brand is being used, I, personally, would place much more reliance upon a one-day test made on the work than upon a seven-day test made on a sample taken at the mill. If mill tests are used, however, check tests for time of setting should always be made on the work.

Although the common period for tests is seven days, it is often permissible to use a familiar brand in a one-day test, for if all the other properties are similar to those commonly found it may generally be assumed that the seven-day strength will also be similar. A three-day sand test is often a convenient guide for the early acceptance of a shipment.

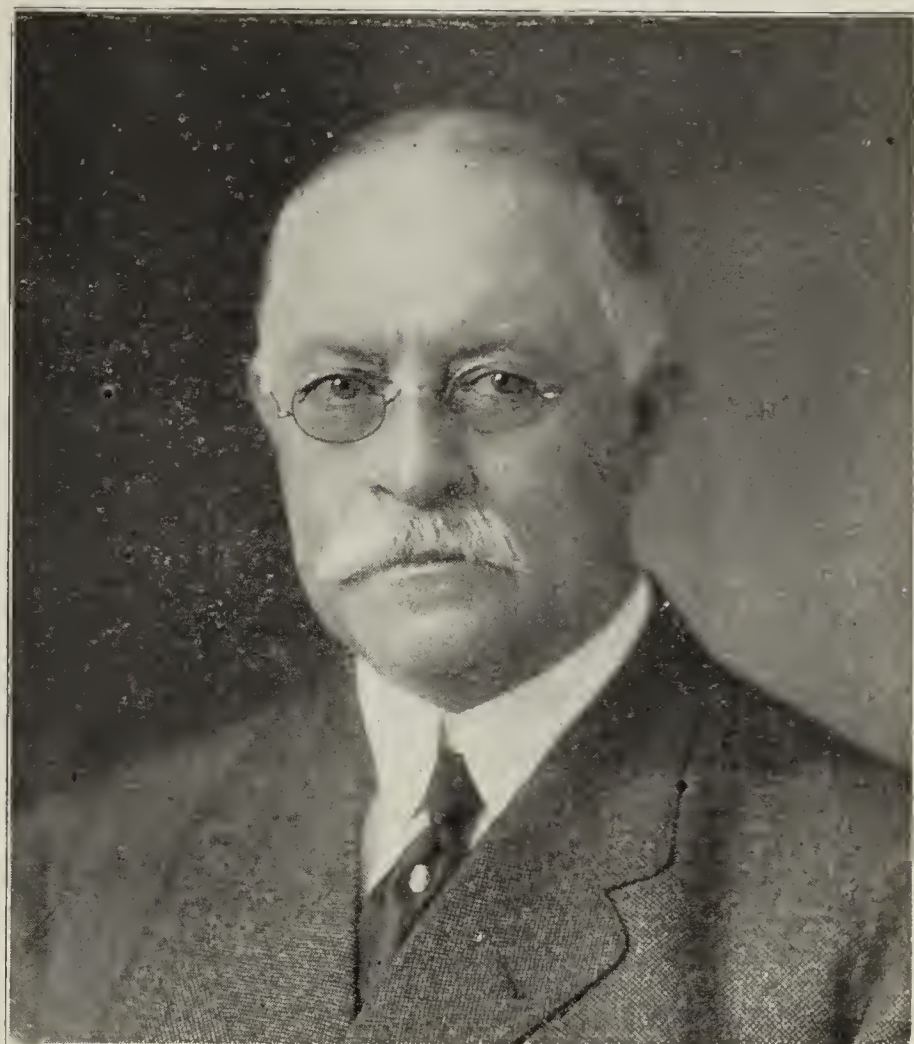
The tests that give the best indication of the quality of a shipment are soundness, sand-strength, setting, fineness and percentage of sulphuric acid. Net strength and specific gravity have generally but little value as acceptance requirements. Of these tests all can be completed in thirty hours from sampling, except the seven-day strength. If a three-day sand test is used in addition, little if any delay will be necessary while waiting for tests.

In conclusion; well-made tests of cement are of the greatest importance and value to every consumer of cement, but they must be made with the greatest care and only by responsible and trained men. If so made, the tests are well worth the time and trouble they cost. A cheaply made test, however, is liable to prove an expensive investment.

W. FREDERICK MAIN.

W. Frederick Main, of the Chicago Portland Cement Co., one of the best known cement salesmen in the Northwest, died at his home, 2921 Washington Boulevard, Chicago, March 15, after a brief illness. Loved by all who knew him, his death was a severe shock to the building trade fraternity. Frederick Main was a man with a big heart, who made many friends and retained their friendship always. Born in Chicago in 1855, Mr. Main grew up with the city. The home of his parents was situated at the corner of Halsted Street and Jackson Boulevard, where Frederick was born, and his early education was received in the school which stood on the present site of the Boston Store. Later, he attended the Skinner Grammar

School and West Division High School. Mr. Main made his first start in life in the insurance business, identifying himself with the Republic Fire Insurance Company, one of the few Chicago companies which successfully weathered the storm of 1870, the year of the Chicago fire. The late Joseph E. Payson was then president of that company and, being of an inventive turn of mind (the Payson patent transom lifter, the Payson sash and the Payson lock are of his invention), he embarked in the hardware specialty business and was joined in this venture by his colleague, Mr. Main. For several years following, Mr. Main, clearly demonstrating his sales ability, the business of the Payson Mfg. Co. was expanding rapidly under his guidance and, though still a young man, his early success led up to his appointment as treasurer of the company, which office he held until the death of his life-long partner, Mr. Joseph R. Payson, Sr., in 1902. Mr. Main and the surviving partners of the Payson Mfg. Co. sold their interest in the concern shortly after, and it was then he became connected



The late WM. F. MAIN of Chicago

with the Chicago Portland Cement Co. His efforts in recent years have been mostly confined to Chicago and adjacent territory, but at conventions and shows held further afield Mr. Main was always on hand to greet his many friends. He was a well known figure at the Chicago Athletic Club, of which he was a member, and was for years chairman of the House Committee of the Illinois Club.

PATENT NOTICE.

In order that the users of waterproof cement may be informed in the premises, we desire to call attention to the fact that the Medusa Concrete Waterproofing Company is the owner of certain original letters patent for waterproof Portland cement and the process of making the same, and that it is the intention of this company to protect its rights under these letters patent and prosecute manufacturers and users of waterproofing material who infringe any of them.—Medusa Concrete Waterproofing Co., Sandusky, Ohio.

REICHERT METAL FORMS.

One of the most important systems yet developed whereby steel has supplanted wood in the making of forms for concrete wall and floor construction, is that known as the Reichert System of Metal Forms. An example of a recent large job carried out successfully under the most trying conditions, is illustrated in the accompanying photograph, which shows the plant erected for the Pacific Coast Condensed Milk Co., at Berlin, in Northern Wisconsin. The photograph was taken about Christmas time, and during the building period the temperature fell as low as 26 degrees below zero. Owing to this handicap, the work could proceed only comparatively slowly, yet fairly rapid progress was made. The form cost in this case ran about 1¾ cents a square foot; but under normal weather conditions, when the men would not have had to work on ice-covered scaffolds and in bitterly cold weather, we are told that the form cost could have been brought down to 1 cent a square foot. The building shown is 200 by 175 feet, with walls averaging about 38 feet above footings. The walls are 11 inches thick to a point 2 feet above grade, 9 inches thick to second floor level, and 6 inches thick above, with a 12-inch fire-wall through center of building. The thin walls are strengthened by pilasters, 6 by 24 inches, at about 18-foot intervals. The Milk Company have already used these forms on a new building, which is already completed, at Richland Center, Wis., and expect to use them again in constructing more concrete factory buildings at Oregon, Ill., and Chilton, Wis. The Stone & Webster Engineering Corporation were the

to fill them. On floor work the saving of time is even greater. Four men, accustomed to handling the forms on wall construction, but unfamiliar with floor work, set up the forms for a floor panel, 22 by 38 feet with an 8 by 12-inch girder, and had it ready for concrete in 2½ hours, under ordinary working conditions.

PROPOSED STANDARD SPECIFICATIONS FOR TESTS OF DRAIN TILE AND SEWER PIPE.

Adopted by the Iowa Association of Cement Users at Cedar Rapids, Iowa.

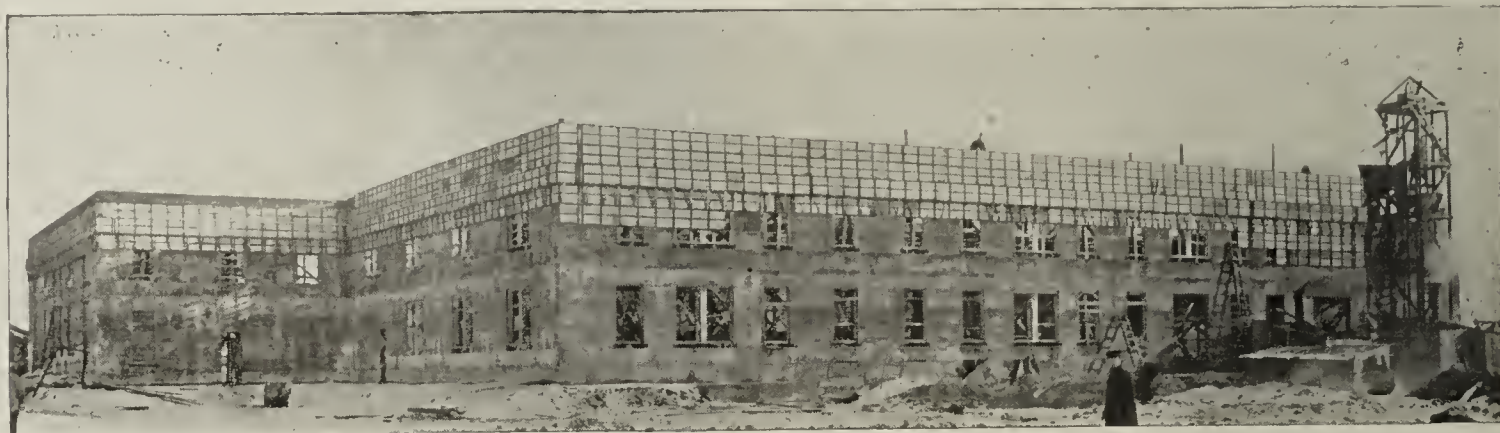
Specifications for Standard Absorption Tests.

1. Specimens. The specimens shall be each approximately two inches square, and shall extend the full thickness of the pipe wall, with the outer skins unbroken.

2. Number of Test Specimens. Five individual tests shall constitute a standard test, the average of the five, and the result for each specimen, being given in the report of the test.

3. Drying Specimens. Each specimen shall be dried in an oven or by other application of artificial heat, until they cease to lose further appreciable amounts of moisture when repeatedly weighed.

4. Brushing Specimens. All surfaces of the specimens shall be brushed with a stiff brush before weighing the first time.



Plant of Pacific Coast Condensed Milk Company, at Berlin, Wis. In this View the Walls are Completed, and the Reichert Metal Forms are up for Construction of the Cornice.

contractors for these buildings and were so well satisfied with the results accomplished with the forms that the Reichert Company recently shipped them a carload of forms for use on the proposed plant of the Minneapolis General Electric Company, work on which has just commenced.

The Reichert system of metal forms is based on a unit-plate 24 inches square. Fractional sizes permit the construction of walls of any length or floor-panels of any dimensions, and rigid and hinged corner connections enable the builder to make angles at any degree. The plates are solidly built of galvanized sheet, reinforced with mild steel angles. Each plate is fitted with a simple locking device (not detachable), by which it can be quickly and securely fastened to the adjoining plate or to the corner connections. Stave-rods, adjustable to the thickness of wall desired, separate the plates, which are wired together through the wall the same as ordinary wooden falsework.

Two workmen, it is claimed, can set up and wire the first course of forms for 150 linear feet of wall in two hours. This portion of the work done, and the line gotten, the builder can start his mixer. Two men can then set up and wire the other courses of plates, faster than the average mixer can turn out concrete

5. Weighing. The specimens shall be weighed immediately before immersion, on a balance or scales capable of accurately indicating the weight within one-tenth of one per cent.

6. Water for Standard Test. The water employed in the standard absorption test shall be pure soft water, at the air temperature of a room which is artificially heated in cold seasons of the year.

7. Immersion of Specimens. The specimens shall be completely immersed in water for a period of twenty-four hours.

8. Re-weighing. Immediately upon being removed from the water, the specimens shall be dried by pressing against them a soft cloth or a piece of blotting paper. There shall be no rubbing or brushing of the specimen. The re-weighing shall be done with a balance or scales capable of accurately indicating the weight within one-tenth of one per cent.

9. Calculation of Result. The result of each absorption test shall be calculated by taking the difference between the initial dry weight and the final weight and dividing the remainder by the initial dry weight.

Specifications for Standard Tests of Bearing Strength.

1. Specimens. The specimens shall be unbroken,

full sized samples of the pipe to be tested. They shall be carefully selected so as to represent fairly the quality of the pipe.

2. Number of Specimens. Five individual tests shall constitute a standard test, the average of the five and the result for each specimen being given in the report of the test.

3. Drying. The specimens shall be dried by keeping them in a warm, dry room for a period of at least two days prior to the test.

4. Weighing. Each dried specimen shall be weighed on a pair of reliable platform scales just prior to the test.

5. Bedding of Specimen for Test. Each specimen shall be accurately marked, with pencil or crayon lines, in quarters, prior to the test. Specimens shall be carefully bedded above and below in sand for the one-fourth circumference of the pipe, measured on the middle line of the tile wall. The depth of the bedding above and below the tile at the thinnest point shall be equal to one-fourth the diameter of the pipe, measured between the middle lines of the tile walls.

6. Top Bearing. The top bearing frame shall not be allowed to come in contact with the tile or with the test load. The upper surface of the sand in the top bearing shall be made level and shall be carefully covered with heavy cross plank or timbers capable of uniformly distributing the test load without any appreciable bending. On top of these cross plank or timbers shall be placed a heavy longitudinal timber capable of distributing the load to the cross timbers without any appreciable bending. The test load shall be applied at the exact center of this top timber in such a way, either by the use of a spherical bearing or by the use of two rollers or rods at right angles, as to leave the timber free to move in both directions. In case the test is made without the use of a machine and by piling on weight, the weight may be piled directly on a platform resting on the cross timbers, provided, however, that the weight does not touch the top frame holding the sand, and provided further that the weight is piled in such a way as to insure uniform distribution of the load over the top surface of the sand.

7. Frames for Top and Bottom Bearings. The frames for the top and bottom bearings shall be composed of timbers so heavy as to avoid any appreciable bending by the side pressure of the sand. The frames shall be dressed on their interior surfaces. No frames shall come in contact with the tile during the test. A strip of soft cloth may be attached to the inside of the upper frame on each side along the lower edge to prevent the escape of sand between the frame and the tile.

8. Sand in Bearings. The sand used for bedding the tile at top and bottom shall be material which has passed a No. 8 screen and has been retained on a No. 16 screen. It shall be dried by keeping it spread out thin in a warm, dry room.

9. Application of Load. The test load shall be applied gradually and without shock or disturbance of the tile. The application of the load shall be carried on continuously, and the tile shall not be allowed to stand any considerable length of time under a load smaller than the breaking load.

10. Calculation of the Bearing Load. The total breaking load shall be taken as equal to the total top load, including the weight of top frame, sand for top bearing, top bearing timbers, etc., plus five-eighths of the weight of the pipe. This total load shall be divided by the length of the pipe in feet so as to give the bearing strength per linear foot of pipe.

Specifications for Calculating the Modulus of Rupture in Standard Tests of Drain Tile and Sewer Pipe.

The modulus of rupture for drain tile and sewer pipe shall be computed from the results of the standard test for bearing strength, according to the following rule:

Divide the bearing strength per linear foot by twelve, multiply the quotient by the radius of the middle line of the tile wall expressed in inches, and divide this product by the square of the minimum thickness of the tile wall at top or bottom, also expressed in inches. This quotient will be the modulus of rupture of the pipe expressed in pounds per square inch.

CONCRETE BRIDGES AND CULVERTS,

By Thos. H. MacDonald,

Iowa Highway Commission—5.

The past year has been a particularly favorable one on account of climatic conditions for construction work of all kinds. Particularly is this true of culvert and bridge work. Undoubtedly concrete was more widely used for this purpose during 1910 than in any previous year. There is a general movement toward the adoption of this material for use in structures of this character, and it should be the privilege, as well as the duty, of such organizations as this to influence and direct this use along right lines. Little advertising or persuasion is necessary now to convince township or county-road officers that the best material for their water-ways is concrete. A great deal of work, however, can be done profitably to insure the best types of construction and the proper use of the material by public officials and contractors for these purposes.

In general, the types in use now are circular culverts built over collapsible moulds; slab top or box culverts; arches; I-beam construction, including I-beams supporting a concrete floor; and I-beams piling, with concrete floors are used to some extent.

The types of bridges and culverts recommended by the Highway Commission are as follows:

First. Round culverts built over collapsible moulds with a small amount of longitudinal re-inforcements, including all sizes up to a 36 inch diameter.

Second. Box culverts or slab bridges from 2 ft. to 20 ft. span.

Third. Re-inforced concrete arches from 8 ft. span up to 100 ft. span, used where the foundation and head room are favorable.

Fourth. Pony truss bridges, from 30 ft. span to 80 ft. span, with re-inforced concrete floors.

Fifth. Re-inforced concrete girders of either the through or deck type, from 25 ft. to 50 ft. span.

There have been no notable failures of concrete work in the state during the past year. There are, however, we believe, some serious mistakes being made that will eventually result in failures. The mere fact that a bridge or culvert is standing is no reason for assuming that it is a safe kind of structure to build.

Among the costly mistakes that have been most frequently made is that of low bidding. Concrete work is not and never will be cheap work, and concrete workers should not attempt to compete in first cost with bridges of other less permanent material except under very particular circumstances. The fact that concrete work well done is permanent, entailing practically no maintenance charges, should be sufficient to off-set, in the minds of public road officers, the somewhat higher investment. We have found that bids on plans prepared by the Highway Commission and on which the competition has been strong, have almost invariably been below the estimated cost. On the other

hand, it is apparent that contracts have been taken at a loss by many concrete contractors, because of the rank favoritism that prevails in so many counties or on account of the conditions that have been imposed upon contractors which has effectually eliminated competition. Iowa can and should offer an open field to the cement contractors of the state. Under existing methods and conditions, this field is closed. In probably 75 % of the counties of this state, there is not such a thing as actual competition in the bridge business. We are very much in need of some laws that will give all men who wish to do public work and are capable of doing good work, an equal chance.

In response to the demand for concrete bridges, the steel I-beam bridge has been encased in concrete and used extensively in some counties. This is a needless waste of steel, as a few rods of steel would re-inforce the abutments far more effectively and the prices that have been paid for this material are far in excess of the market value. When used for floors, the I-beam construction is not economical, as the I-beams must carry their own weight plus that of the concrete floor plus the loads that pass over them. This is not re-inforced concrete construction, and if the I-beams are sufficiently large to take the superimposed loads, the cost, complete with concrete floor, would be considerably more than the slab, re-inforced with steel rods.

There have been built during the past several years in this state, a form of re-inforced concrete arch called the Lutten type, which is patented under patents controlled by the National Bridge Co. The Highway Commission has undertaken to investigate these arches thoroughly, so as to be able to make a definite report to county boards which may be considering this type. Preliminary analysis of two structures shows that to provide for the temperature stresses, it would be necessary to add considerable re-inforcing steel to the arch ring. This type of bridge contains a minimum amount of both concrete and steel.

There are many mistakes made in concrete construction due to incomplete knowledge of the men handling the material or insufficient supervision. Among these mistakes are the misplacing of re-inforcing steel. Careless placement of the steel re-inforcing is a really serious matter, for in the use of slabs and their sections, a minimum thickness is nearly always used. If, then, the steel is misplaced even one-half inch from its figured positions, the calculated stresses will be greatly increased, and if in a thin section, the steel is misplaced one inch, then the stresses induced may cause serious cracks or even failure.

There is another class of mistakes which may not be excused or lightly passed over. These are the intentional mistakes, and this association must realize that its life and development depend upon the work of the individuals composing it. In Cedar County, in 1909, the county culvert work was let on specifications that went to an extreme in providing both cement and re-inforcing material. The contractor who built the work bid considerably too low, and not only skinned the work of cement and re-inforcement, but padded his bills. Again, we have just received a statement, showing that a contractor who was paid for over 100 cubic yards of concrete, used just 200 sacks of cement, about one-third of the amount which should have been used. Such work as this simply retards the concrete industry and does not in the end profit the man who so abuses his chosen industry. Iowa can afford in all her public works to pay for the highest type and class of work, especially all that may be classed as permanent. This association should insist both upon high class work and upon high class men to handle the work.

THE UNIVERSAL PORTLAND CEMENT MILLS.

Mills 3 and 4 of the Universal Portland Cement Company are located at Buffington, Ind., on Lake Michigan, about 11 miles southeast of South Chicago and 5 miles west of Gary. These are two distinct units, both being controlled by one head of operation and supplied from one central point of power distribution. Both are laid out on the same general plan. The raw material is brought to the plant in cars and delivered onto one line of elevated track which supplies both plants. Here it is dumped into bins for the several mills, and from then on, until it is packed in bags ready for shipment, it is handled by electrically operated machinery.

No description of the mills has ever been allowed by the company prior to the appearance of the following notes concerning their electrical equipment, which have been published recently in the "General Electric Review." They were written by Mr. E. A. Hultz. Since both plants have practically the same layout, only that of No. 4, which is the more recent, is dealt



Gasoline Switching Locomotive for Industrial Plants, described on page 122 of our March issue. Manufactured by Milwaukee Locomotive Co.

with in detail. All motors are of the squirrel-cage induction type, unless otherwise specified, and the entire electrical equipment mentioned is of General Electric manufacture.

The raw material used is limestone and blast furnace slag. The limestone first passes through three No. 4 Gates crushers, whence it is delivered to 50x5-ft. driers. One 20hp, 750-r.p.m. induction motor operates one crusher and one drier through group drive. The power is transmitted from the motor through a flexible coupling to a jack shaft which drives the drier and crusher. This method of drive is stated by Mr. Hultz to be ideal, as all vibration and sudden strains are taken up in the flexible coupling, thus allowing the motor to operate under the best conditions.

The slag first passes through four 50x5ft. driers, each individually driven through flexible couplings by a 10-hp, 750-r.p.m. form M variable-speed induction motor. A very great advantage is said to be obtained by using these variable-speed motors, for at times, if the material is very wet, it is necessary to run the drier slowly to obtain a uniform degree of dryness. This variable-speed drive with alternating current motors is remarkably satisfactory, Mr. Hultz says.

The driers are fired by the combustion of pulverized coal with low-pressure air. A long screw conveyor running the entire length of the raw material building delivers the pulverized coal into the tried hoppers, and

is driven by a 30-hp induction motor. From these hoppers the coal is fed into burners by a small screw conveyor operated by disk friction from a line shaft which takes care of all the driers, this shaft being driven by a 10-hp, 750-r.p.m. induction motor.

The air is furnished by two Buffalo blowers running at 750 r.p.m., each being driven through a flexible coupling by a 10-hp induction motor. This particular drive is remarkable for the smooth running of the motor, all the vibration of the fans being taken up in the flexible couplings.

From the driers the crushed limestone is lifted to ball mill hoppers by three 45-ft. elevators, all three elevators being driven by one 5-hp induction motor. The motor is belted to the shaft driving the elevator heads and located high among the roof trusses of the building, thus illustrating the adaptability of this type of motor for use in places not easily accessible.

From the slag driers the material is elevated to the ball mill hoppers by four elevators of the same dimensions as the stone elevators and driven by one 5-hp induction motor; the method of drive being similar to that employed for the stone elevators.

From the ball mill hoppers the stone passes through eight No. 8 Gates ball mills, and the slag through three. Each of these mills contains about 4500 lb. of 4½-in. steel balls and is individually driven by a 40-hp, 166-r.p.m. slow-speed induction motor, the motor shaft being directly connected by means of a flexible coupling to the pinion shaft which drives the mill. The starting torque required by these ball mills is very high, varying from two to three times full load torque, and the running conditions are about the most severe that could be found. However, the very liberal design of the motors and the well-developed flexible coupling, Mr. Hultz says, have resulted in practically no wear and tear on the motors, although they have been running constantly day and night for nearly three years. The motor bearings are absolutely dust-proof and self-lubricating and, although the motors are in the dustiest part of the entire mill, there has been no expense for maintenance of the bearings other than that of changing the oil about every three months.

In plant No. 3 similar ball mills were originally driven by higher speed motors, both belt and gear drives having been tried. Owing to the exceptionally high maintenance cost on account of frequent changes in bearings and rewinding of motors, a radical change was desired when designing plant No. 4. Up to that time no small induction motors of sufficiently low speed to operate under these conditions had been built, but after a careful study by the engineers it was decided to omit one gear reduction entirely and flexibly connect special low-speed motors directly to the countershafts of the several mills. The wisdom of this radical selection as a remedy for the previous troubles has been proved, according to Mr. Hultz, for the results in decreasing maintenance cost and entirely eliminating delays has been far beyond expectations.

From the ball mills the material is delivered to twin elevators by means of a belt conveyor driven by a 5-hp induction motor. These twin elevators, which are each driven by a 20-hp, 750-r.p.m. induction motor, take the material to a height of 63 ft. and deliver it to scale hoppers. Material is delivered from the scale hoppers to the scales, of which there are two sets, by means of two screw conveyors. These conveyors are operated through electric clutches by a 10-hp, 750-r.p.m. induction motor. The material is automatically weighed, registered and dumped by electrical apparatus which gives exact results at all times and a positively uniform mixture.

The automatic electric weighing machines were developed and patented by the engineers of the cement company, and are probably the most accurate and reliable devices of this nature in existence. Each scale has two hoppers, separately balanced, and so arranged as to dump into a common mixing receptacle. The screw conveyor feeding each hopper is automatically stopped by magnetic clutches when the predetermined weight is delivered to the scale hopper, and it is impossible to dump either hopper until both have received the correct quantity of the two ingredients. The two hoppers are dumped simultaneously, thus insuring not only correct proportions in the mixture, but a perfect mechanical mixture before the material passes to the next stage of manufacture. The material is mixed by means of a mixing screw, which is driven from the shaft that drives the electric clutches. The mixture is next lifted through a height of 55 ft. to the tube mill hoppers by two elevators, each driven by a 10-hp, 750-r.p.m. induction motor. It next passes through twelve 22x5-ft. tube mills half filled with flint pebbles. Each of these tube mills is individually driven by a 100-hp, 166-r.p.m. induction motor connected through a flexible coupling to the pinion shaft driving the tube mill, the arrangement being similar to the ball mill drive.

In plant No. 3 the tube mills were driven by 480-r.p.m. induction motors connected through intermediate gears to the tube mill pinion shaft. This method of drive resulted in such high maintenance costs on account of wear on both the gears and the motors that when plant No. 4 was built it was decided to install a single reduction drive. The first very slow-speed motor of this type was installed in June, 1907, and is still running, having caused no delays for repairs since it was started.

The tube mill motors are in a lean-to, which is separated from the rest of the mill, making a clean, ideal place for a drive of this kind.

All of the form K motors throughout the plant are started by means of three-pole, double-throw switches, oil switches being used on the larger motors. A low voltage line from various banks of auto transformers supplies the starting circuit for all of the motors.

From the tube mills the material is carried by means of a belt conveyor to a 47-ft. elevator, from which it is delivered to a screw conveyor and then to a distributing conveyor for the kiln hoppers. The conveying machine is belt-driven by a 40-hp, 750-r.p.m. induction motor.

The coal house which furnishes pulverized coal for the various mills is located next to the elevated track at the end of the raw mill and facing the burner building. The coal is fed by gravity into crusher hoppers directly under the bins. There are three No. 1 Williams coal crushers and three 50x5½-ft. driers for crushing and drying the coal. Each crusher and its drier is driven by a 750-r.p.m. induction motor through a flexible coupling and a countershaft. The coal is taken from the driers to the pulverizer hoppers by a screw conveyor and an elevator, driven in the group by a 5-hp, 750-r.p.m. induction motor.

There are eight 33-in. Fuller-Lehigh pulverizer mills which take the coal from the hoppers, each mill being belt-driven by a 40-hp, 500-r.p.m. vertical induction motor of the two-bearing type. Each bearing is automatically oiled, is dust-proof and is independent of the other. The motor is mounted on the shaft above the pulley, the latter being just above the lower bearing. The output of the entire plant depends upon the operation of these motors, as they furnish pulverized coal for all the burning. Their performance has been

very satisfactory. The pulverized coal is taken from the coal house to the raw mill and burner buildings by two long screw conveyors, each driven by a 10-hp, 750-r.p.m. induction motor.

The burner building contains twelve 120-7½-ft kilns, each belt-driven by a 15-hp, 750-r.p.m. induction motor. The control for each kiln motor is located in front of the kiln at the hand of the operator. Three Buffalo blowers furnish the low-pressure air for burning, each of which is driven through a flexible coupling by a 20-hp, 750-r.p.m. induction motor. This drive is identically similar to the blower drive in the raw mill.

There are six 46-ft clinker elevators, each driven by a 5-hp, 750-r.p.m. induction motor, the control for which is located on the main floor, alongside of the corresponding kiln control. One elevator takes care of two kilns, delivering the clinker into the clinker pit, where it is handled by three-phase electric cranes.

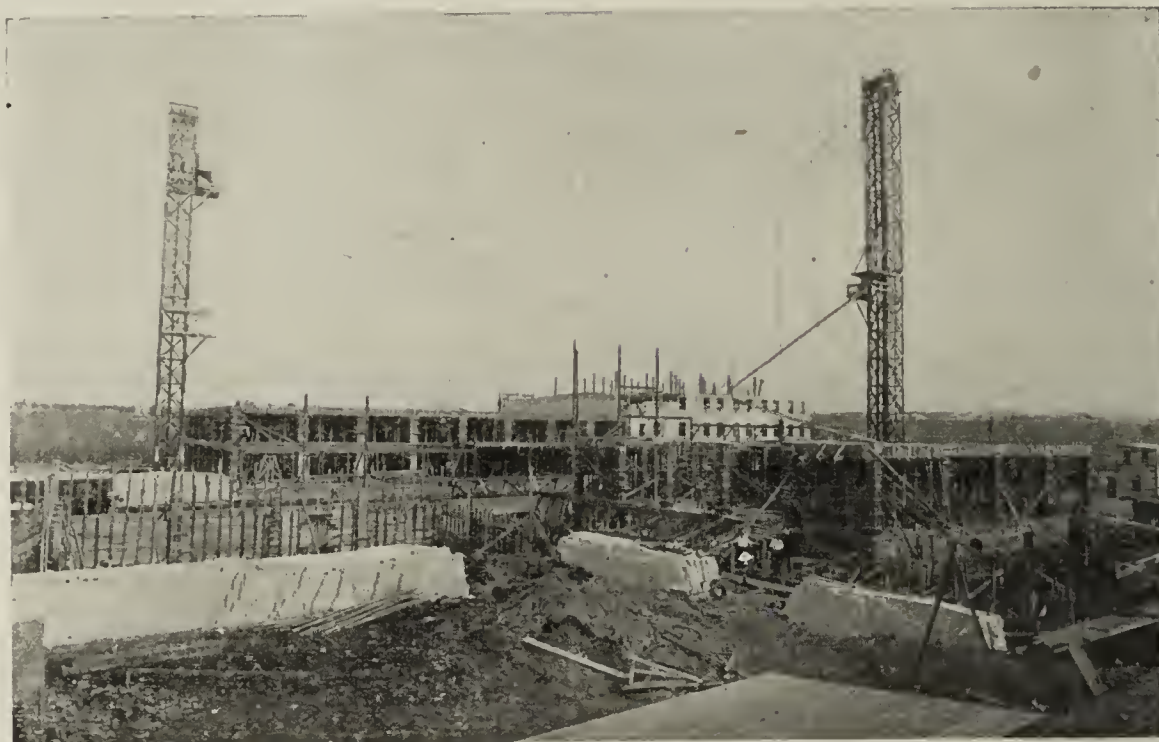
Two 10-ton Alliance cranes are installed, each having the same electrical equipment. The 3-ton grab bucket is operated by two 37-hp, 680-r.p.m. crane motors, one motor closing and opening the bucket, the

the No. 3 plant. Three 45-ft. elevators deliver the cement from each group of four Kent mills to the tube mill hoppers, each elevator being driven by a 10-hp, 750-r.p.m. induction motor.

Fifteen 5x22-ft. tube mills take the cement from the tube mill hoppers. Each of these tube mills is driven by a 100-hp induction motor through a flexible coupling attached to the master pinion shaft; this being the same style of drive as that used on the raw mill tube mills. At the back of the tube mills is a 208x2-ft. belt conveyor driven by a 10-hp, 750-r.p.m. induction motor. From this conveyor cement is delivered to the top of the stock house by means of a 170x2-ft. inclined belt conveyor driven by a 10-hp, 750-r.p.m. induction motor. In the top of this stock house, delivering the cement to the various bins, is a 600x2-ft. belt conveyor driven by a 20-hp, 750-r.p.m. induction motor.

All the motors in the entire plant are equipped with dustproof bearings and are blown out by compressed air every 24 hours.

Power is delivered to the substation at 22,000 volts



Constructing a Reinforced Concrete Packing Plant
Sioux Falls, S. D.

John Morrell & Co., Owners. Collins Bros., Contractors
D. I. Davis & Co., Chicago, Architects and Engineers.

other raising and lowering it. The trolley travel is operated by an 11-hp, 680-r.p.m. crane motor; a 37-hp, 680-r.p.m. crane motor driving the bridge travel. Each motor is controlled by a suitable controller located in a cage at the end of the crane. The crane motors are of the slip ring, wound motor, variable speed, alternat-current type. The service required of these cranes is very severe, each handling 6500 barrels of clinker daily. The motors are subject at all times to constant stopping, starting and reversals under very heavy loads. The motors are of the skeleton frame open type and operate out of doors in all kinds of weather. They have proved very satisfactory. The cranes take the hot clinker from the burner building spouts, pile it up to cool, and then carry the cool clinker into finishing mill hoppers, where it is fed into Kent mills.

In the finishing mill there are twelve 40-hp, 500-r.p.m. induction motors, each direct connected through a flexible coupling to a jack shaft from which a Kent mill, elevator and Newaygo screen are driven. These motors are run in the dustiest part of the whole mill, 24 hours every day, under overloads that are very severe and frequent. This motor and type of drive proved such a success that nine more were installed in

from both South Chicago and Gary. The substation is so laid out that power may be transmitted from South Chicago to Gary, or vice versa, or both South Chicago and Gary may feed into the cement plant, thus insuring a constant supply of power. Each 22,000-volt line is protected by aluminum cell lightning arresters.

As in other cement plants, Mr. Hultz reports, new apparatus is constantly being tried out and additional power is demanded, thus causing a considerable tax on the generator and transformer capacity. Several conditions arose during the past year in this respect which made it evident that some steps must be taken in the direction of permanent improvement. The substation power factor was about 76 per cent and the generating units at South Chicago were overloaded when called upon to furnish full load current to the cement plant. Further, the heavy inductive load at Buffington made it very hard to keep the stations at South Chicago and Gary in step. Conditions were studied very carefully, calculations were made, and it was decided to install two synchronous condensers. Operating conditions have been greatly improved by the installation of these machines, as the following

statements will indicate. In addition to helping out the generating station, which was the main purpose of the installation, the high-tension line losses were decreased and the efficiency of the low-tension feeders distributing power to the various mills was increased. Better voltage regulation was secured at Buffington, the capacity of the transformers was increased and operating conditions between the two generating plants was greatly improved. As a whole, Mr. Hultz states, the installation has proved very successful. It has been estimated that \$10,000 annually has been saved in the cost of power.

A 7000-kw., 25-cycle, 2300-volt mixed-pressure Curtis turbine has been installed recently in the South Chicago plant of the Illinois Steel Company. This turbine furnishes additional power for the cement plants at Buffington and the steel mills at South Chicago, taking its low-pressure steam from the exhaust of the high-pressure reciprocating steam engines that operate the blowing engines and alternators. The valves admitting steam to the buckets of the turbine are so arranged that if the supply of low-pressure steam is cut off high-pressure steam is admitted automatically. The turbine exhausts into a high vacuum condenser and operates under very favorable conditions, according to recent tests.

CEMENT RATE SUIT FILED.

Charging that there has been gross discrimination by railroads in favor of the Universal Portland Cement Company both in rates and in regulations for shipments, the Alpha Portland Cement Company of Jersey City, N. J., which operates cement plants in various cities throughout the country, filed a complaint with the interstate commerce commission recently against the Baltimore and Ohio Railroad and practically all other carriers in the territory east of Chicago and in the Northwest.

It is alleged by the complainant that the Universal Company is controlled by the United States Steel Corporation and through that affiliation obtains freight rates which are materially lower than those granted to the Alpha Company.

TESTS OF SOFT SOAP FOR WATERPROOFING CONCRETE.

A large grain elevator and flour warehouse has recently been built on the bank of the River Donau in Budapest on ground subject to high floods. It was, therefore, imperative that the foundation, which consisted of a concrete mattress varying in thickness from $5\frac{1}{2}$ to $6\frac{1}{2}$ ft., should be thoroughly waterproofed. Preparatory to this work chemical analyses were made of the various waterproofing compounds in common use, and these indicated that the chief constituent and probable active waterproofing agent of most of them was potash or soft soap (*kaliseife*). Upon the recommendation of Dr. Ing. Zielinski the waterproofing layer was made 10 cm, 4 in., thick, consisting of 9 cm of concrete, in which stone of a maximum size of $1\frac{1}{2}$ cm was used, and of a 1-cm layer of 1:3 mortar made with fine sand. The 9-cm layer of concrete contained 800 lb. of cement per cubic meter, 1.3 cu. yd., and was tamped hard. The mortar layer was put down with a wood float. Instead of using pure water in mixing the concrete and the mortar a solution of soft soap was

used, the proportions being such that there were 6.6 to 8.8 lb. of soap per cubic yard of concrete and mortar.

Shortly after the completion of the work the foundation was subjected to a high head due to a flood and was found to be perfectly water-tight, though a similar foundation close by, which, however, had not been waterproofed, allowed the water to seep through.

In order to determine with some accuracy the action of the soap as a waterproofing agent a test, reported in "Beton und Eisen," was made on a small concrete box. The box was 20 in. square and 11 in. deep, with bottom and sides 10 cm, 4 in. thick, 9 cm being of the waterproofed concrete above described and 1 cm of the waterproofed mortar. After hardening for 10 days the box was filled with water and placed out of doors for 28 days, where it was subject to rain, wind and direct sunlight.

The box was then emptied and the mortar carefully removed in thin layers in order to learn to what extent the water had penetrated the bottom and sides. The top layer of 1 mm was completely saturated, had a dark gray color, and less density than normal 1:3 mortar should have. An examination of the structure of the mortar when magnified three times showed that the saturation of the layer was uniform. The next 1-mm layer was somewhat damp, but thoroughly dense. Beneath this layer the mortar and concrete had the appearance of normal, air-hardened, dry concrete. When cut with a chisel it was found to be very hard.

A chisel cut $1\frac{1}{2}$ cm deep was then made in the bottom and the box again filled with water and allowed to stand for 10 days. At the end of that period it was found that water had penetrated the concrete for a depth of 1 cm around the cut, while the undisturbed layer of mortar on the remainder of the bottom and the sides of the box had been penetrated 2 to 3 cm.

IMPERMEABILITY TESTS OF CONCRETE.

In order to discover some method of waterproofing which would produce impermeability in mortar and concrete only 4 in. thick when subjected to a head of water of 100 ft., and which would not be prohibitive in cost, a series of tests was made at the Engineering Experiment Station of the Iowa State College, Ames, Ia., by Mr. W. A. Burton. The specimens were in the form of pipes, 18 in. long, 6 in. in inside diameter and 4 in. thick. The concrete was mixed in proportions of 1:2:3 $\frac{1}{2}$, though there were a few specimens mixed 1:3:5. Atlas Portland cement, fairly well graded sand with 35 per cent voids, gravel retained on a No. 8 sieve and running up to $1\frac{1}{2}$ in. in diameter, and crusher-run stone passing a $2\frac{1}{2}$ -in. screen were used. The mix was moderately wet, so that it would quake with a little agitation. The waterproofing materials were clay, alum and soft soap, and reground cement. A few wires were imbedded for reinforcing. The pipes were tested between bulkheads of $2\frac{1}{2}$ x16x16-in. plates held against the ends by eight 1-in. bolts. A $\frac{1}{4}$ -in. rubber gasket was placed between the plate and the pipe.

In the first set of tests, made with pipe 60 days old, the measurement of water passing in 20 minutes at the end of 3 hours was chosen as the standard. At the end of this time the pipe would in most cases have reached its maximum leakage. In some of the best pipes it appeared later that maximum leakage may not come for a couple of days, but still there was not much leakage after 24 hours. In the second set of tests it was first intended to find a pressure for each kind of

pipe at which there would be no leakage after 24 hours, but this was found to involve so many guesses that instead it was decided to test at the age of 90 days under the same conditions as in the first test, except that the measurement was made at the end of 24 hours instead of 3 hours. All of the best pipes tested as well or better in the 90 than in the 60-day test.

The following summary gives the conclusions reached by Mr. Burton: All of the tests showed that broken stone is much better for impermeability than gravel. The effect of clay, which had been prepared by grinding until 98 per cent passed a No. 200 sieve, was rather disappointing. When the cement was replaced by 10 per cent of clay the leakage was decidedly cut down as compared with specimens having only 5 per cent of clay. One specimen containing no waterproofing showed practically no leakage. The soap and alum waterproofing gave very satisfactory results, the pipe tested when 90 days showing practically no leakage at the end of 24 hours. This specimen was afterward kept under a 45-lb. pressure for 12 days. The maximum leakage, 10 drops per minute, occurred on third, fourth and fifth days. It then decreased to one drop per minute. The pipes made with reground cement showed less leakage than any of the rest, the leakage being practically nil under a pressure of 50 lb. per square inch. Tensile tests indicated that soap and alum do not materially affect the strength, and that reground cement increases it, the strength of these briquettes being about 25 per cent in excess of those made with ordinary cement.

THE DECIMAL SCALE FOR CONSTRUCTION WORK.

It is generally conceded that the adoption of a single unit of measurement for engineering, architectural and construction work would not only facilitate the work of engineers, architects and contractors, but would also eliminate the chance of making errors in the transference from the engineer's to the architect's scale, and vice versa. In the office of a prominent engineer in Boston for estimating all dimensions are converted from inches to decimals, this involving of course a considerable amount of work, but it is proven that it pays to do this both from the avoidance of errors and in the shortening of the actual arithmetical work by using a decimal system rather than our present system of feet and inches.

It is interesting to note the opinions of prominent men connected with engineering, designing and building operations. Mr. F. W. Reynolds, of Lockwood, Greene & Co., mill engineers and architects, Boston, Mass., says: "We believe that from the engineer's standpoint the decimal scale could be very well adopted for construction work. By this we mean that all measurements could be taken and expressed according to the decimal scale with quite as little trouble and confusion as follows the use of the scale of feet and inches. Drawings would be just as easily made and read if the decimal system was followed as under the present system. We fear, however, that unless the adoption of this system could be made compulsory, it would be the source of many errors from the confusion which would arise after drawings were sent out and into the hands of persons more familiar with the scale of feet and inches than with the decimal system."

Mr. F. W. Dean, the engineer and designer of industrial plants, gives as his opinion that the decimal scale would be a good thing if once introduced and es-

tablished, but that he would hate to be the one to attempt bringing about the change.

The point of view of the civil engineer is well expressed by Mr. Leonard Metcalf, of the firm of Metcalf & Eddy, Boston, Mass. He says: "The difficulty comes essentially from educating the contractor's foreman and men, rather than the inspectors and engineering corps, as the latter are, of course, accustomed to the use of the engineer's decimal scale in all the surveying operations. I believe that in the majority of cases,—more particularly large and important works,—the use of the decimal scale would be possible, but greater difficulty would be encountered in its introduction in the smaller works. The fact must also be overlooked that in such works as involve building-in iron work, castings, structural material, etc., the manufacturers and machine shops still adhere to the English "feet and inch" scale. Under such circumstances either separate plans for details would have to be used, or two different scales would appear upon the same drawing, or dimensions would be stated for both purposes in one scale only. This again would be disadvantageous from the point of view of the mechanic who has become thoroughly accustomed to the foot and inch scale, and in the majority of cases knows little of the engineer's decimal scale. You will see, therefore, that while from the engineer's point of view, the change would broadly speaking be advantageous, from the practical point of view I fear there would be serious difficulty in its general introduction, except perhaps in general classes of work."

The opinion of Mr. L. C. Wason, president of the Aberthaw Construction Co., Boston, Mass., is interesting as being that of a man intimately connected with actual conditions in the field. His opinion follows: "In designing and figuring work in the decimal system, later converting the measurements into feet, inches and fractions, to correspond with the dimensions given by engineers. If engineers and architects could be induced to use decimals it would be a great boon to the profession in general, and of assistance in the execution of work. I think co-operation could be obtained from the manufacturers of rules, who would make it more difficult to get rules divided in fractions of an inch, and turn more of these in decimals, and also who would send out advertising literature showing the advantages of the decimal system. By the co-operation of the manufacturers and the engineers and architects, I believe a result could be accomplished which would be very desirable. I am looking forward with interest to the time when the metric system will become necessary through enactment of law."

THE APPLICABILITY AND COMPARATIVE COST OF CONCRETE AND REINFORCED CONCRETE FOR SUBWAY CONSTRUCTION.

By Charles M. Mills.

Concrete has been used in building metropolitan underground railways from the beginning of such construction. It was used in the structure of the Metropolitan District Railway in London, authorized by Act of Parliament in 1854, construction beginning in 1860, the successive extensions not being completed until

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1884. It was used in backing the haunches of the brick arches, in the footings of masonry sidewalls, in backing behind the sidewalls as the timbering was removed, and later in the sidewalls themselves and in the inverts.

The advantages of concrete have evidently influenced the designs of all the underground railways to the present time. In the earlier construction stone masonry and brickwork predominated, but these have yielded to concrete as its properties and adaptability to meet varied requirements became better understood, its use receiving an impetus by the production of Portland Cement. With the addition of reinforcement, concrete has increased its claim upon designers and constructors, so that to-day it is indispensable, the combination possessing properties and affording facilities possible with no other material. It may be noted that in the railway subways in European cities, concrete has been used mostly without reinforcement, contrary to what might have been expected, while in America, in many cases, reinforcement has been liberally utilized.

The adaptability and advantages of concrete both plain and reinforced to subways is so complete in most respects and is so well understood, that only the salient features will be noticed, with general references to economies.

To attempt to satisfactorily show by figures the savings effected by the use of concrete either plain or reinforced in subway construction, involves the consideration of many conditions to avoid producing misleading impressions. The extent of the permissible interference with street traffic, the nature and density of the traffic, the local costs of materials and the facilities for their storage and handling, the conveniences for handling the excavated material, as well as many other details, all affect the cost. In view of these considerations, no definite figures will be given. It has been a surprise to the writer, that the aggregates of items of cost in different designs for subway structures carefully developed with a view to economy, have varied so little, the differences being small percentages of the entire cost involved.

It is well understood that concrete may be made with ordinary labor under efficient direction, so that its unit cost compared with that of brick work is usually much cheaper, especially under the conditions which prevail in underground construction in busy city streets, and concrete as compared with brick work for this kind of construction is so superior that the use of brick work is now limited to collateral details, such as sewer work, underpinning and miscellaneous work at passenger stations.

For sidewalls, sustaining earth pressure, as well as vertical loads, reinforced concrete is especially advantageous since the thickness may be made but a fraction of that required for walls of brick or stone masonry. Thin side walls reduce the width of the trench to be excavated, an important and costly item of work in city streets and are usually necessary, since the available space under the beds of streets is frequently limited, either by existing structures, or by the necessary reservations for sewers or other underground structures, as municipal requirements increase.

Thin walls also may be built with vertical I-beams to resist the earth pressure with vertical jack arches of concrete between them. The cost of such walls is slightly more than for those of reinforced concrete, the comparison of cost including many details. The I-beams are usually twelve or fifteen inches deep and spaced five to six and one-half feet apart on centres, and require same thickness of concrete back of them to cover the outer flanges. In addition protection of the beams from corrosion and the fact that the wall is

pierced every five or six feet by the beams renders waterproofing necessary. The placing of waterproofing, from the interior of the trench requires a thin wall of brick or concrete outside of the beams. The total thickness of such composite walls without concrete covering over the inner flanges of the beams is usually from twenty-one to twenty-four inches. The inner flanges of the beams being uncovered require painting which entails a maintenance charge. If the inner flanges of the beams are covered with concrete, the total thickness of the wall is increased, and this, together with the details requisite to efficiently secure the concrete to the flanges are additional items of expense.

Little advantage, if any, in supporting traffic during construction is afforded by the beams, unless steel roof beams are used, since the timbering required prior to the erection of the beams may readily be designed to fulfill this purpose.

The sidewalls of reinforced concrete considered in the comparison of cost are taken twenty-four inches thick, though sixteen inches would usually suffice to sustain all the stresses, the additional eight inches or fifty per cent. being placed for practical considerations, partly construction details and partly to diminish liability of leakage. As the thickness of the wall is increased for the reasons stated, the quantity of main reinforcement is diminished with the resulting saving. No waterproofing is considered in the reinforced concrete sidewalls, since with longitudinal reinforcement properly proportioned and distributed in the walls, and with the cement and concrete aggregates properly proportioned, made to a wet consistency and well placed in the forms, the use of waterproofing in reinforced concrete sidewalls is unnecessary under all heads of ground water liable to exist in ordinary subway construction, thus eliminating many troublesome details and simplifying the work.

An advantage of reinforced concrete sidewalls with longitudinal reinforcement is that no expansion joints are required, and long stretches of wall may be built without cracks due to changes of temperature or to shrinkage, or to be more exact with such a multiplicity of distributed minute cracks that they are harmless, and invisible except under the closest scrutiny. The longitudinal reinforcement may be varied to meet the various conditions, and to produce lesser or greater capacity to resist leakage as desired.

The simplicity and superior water tightness of well designed reinforced concrete sidewalls make them worth more than walls of beams and concrete jack arches, even though local conditions might show a slight saving in first cost of the latter.

It is probable that in most cases the first cost of reinforced concrete sidewalls will be a little less than that for the other type, but the difference will be a small percentage of the whole cost.

In the use of reinforced concrete for subways, both for sidewalls and roofs, plates of uniform thickness have generally been employed, instead of an alternation of beams and slabs.

The refinement of workmanship required in placing concentrated reinforcement in beams, with shear rods, and the other details of beam and slab construction is injudicious from practical considerations in underground work. Such work is usually done in restricted space and with artificial light, so that good workmanship is secured only by the closest supervision and painstaking inspection. Though there be no desire to slight the work, the workmen are out of sight and simplicity of details is essential.

Under the conditions, the cost of plates of uniform

thickness, considering the cost of forms and their handling and of the reinforcement and its placing, is less than that for an alternation of beams and slabs, and compensates for the additional material required.

It is probable that with the advance being made in the production of assembled reinforcement handled in units, construction of roofs with an alternation of beams and slabs may be found advantageous, since economies may result to compensate for the additional expense now entailed by such designs, and methods devised to secure good work under the difficult conditions.

Since it is desirable to make the depth from the street surface to the passenger platforms as little as practicable, and the distance from the top of the roof to the street surface is usually determined by the space necessary for the water and gas mains, electrical conduits and other underground structures, the arched roof is often objectionable owing to the increased depth of the structure due to the rise of the arch. Flat roofs have been mostly employed with a moderate slope for drainage.

Flat roofs are built of cross beams or girders with jack arches of concrete, and also of reinforced concrete alone. Due to the considerations previously described the reinforced concrete roofs have been of plates of uniform thickness.

Since the drainage grades on flat roofs are slight, and accidental leaks in roofs are more objectionable than when they occur in sidewalls water proofing is always used.

In comparisons of the costs of roofs the item of waterproofing is common to all styles of flat roofs and reduces the elements of difference to the other features of the designs.

The execution of permanent and water-tight roofs with beams and concrete jack arches involves many details requiring care and it may be said that greater simplicity and superior permanent results are obtainable with reinforced concrete alone.

With beams and jack arches, it is necessary to introduce reinforcement to prevent cracking due to shrinkage and temperature stresses, particularly immediately over the beams where the concrete is liable to crack and cause leaks, water tending to flow along the webs and flanges. Reinforced concrete in such places is superior to any other available material in securing enduring and water-tight work. Another source of leakage where beams are used is the thinness of the concrete back of the ends of the beams where they rest on the sidewalls. Such roofs require careful and efficient waterproofing, and but little dependence should be placed on the waterproofing to bridge over or seal cracks in the concrete.

The cost of flat roof with transverse beams and jack arches of concrete is found to be cheaper than reinforced concrete roofs with plates of uniform thickness. This is partly due to a lack of economy in using plates of uniform thickness and partly to construction details.

From the foregoing it appears that the first cost of a two-track subway with reinforced concrete sidewalls and a roof with beams and concrete jack arches may usually be found less than that of a structure entirely of reinforced concrete, but such inference should be considered with caution for the reasons previously indicated. The difference in cost, if in favor of the beams and concrete jack arches, would be but a small percentage of the entire expense. On the other hand, the permanent advantages of an entire reinforced concrete structure are markedly great, and maintenance charges inseparable from composite structures of structural steel and concrete are eliminated.

As to the cost of various types of structures, it is possible that with space for masonry sidewalls in a subway for two tracks, and with the roof in one span and with favorable conditions, economies might result, so that the cost of such a structure as a whole would not exceed that of one with thin walls of reinforced concrete and might be less.

Reinforced concrete permits the use of arched cross sections in cases where plain concrete or brick masonry would involve uncertain stability under the action of concentrated loads, particularly with the probability of the excavation of trenches parallel to and alongside of the structure. Consideration of the latter contingency is imperative due to the growing demand in cities for underground service for public utilities, and the growth of municipal improvements, by which increasing space is required beneath the streets.

In addition to the sidewalls and roofs of subways, the concrete plain or reinforced, is well suited to the construction of floors, inverts, platforms, stairways and other parts of underground railways. By using the precautions to exclude water by proportioning the constituent and reinforcement concrete may be used for inverts or floors to better advantage than any other known material. This statement applies also to sumps, pumping chambers, underground passages and other deep construction, good results being attainable with less expense than with any other material and much less difficulty.

An interesting demonstration of the advantage of reinforced concrete occurred in the building of the Market Street subway in Philadelphia, between the City Hall and the Schuylkill River, at Twenty-first Street. A large water main on the north side of the street parted at the junction with a main on twenty-first Street, the rush of water excavating a large hole in the street and carrying the debris into the uncompleted subway. A small egg-shaped reinforced concrete sewer built as part of the drainage diversion caused by the subway construction, sustained itself as a bridge with a clear span a little over forty feet wide, and not only carried its own weight, but also a quantity of earth, paving stones and other debris. No fractures were found in the sewer, only some small cracks, and the leakage from the sewer which had been in service for some time amounted only to intermittent drops. The washout was backfilled and the street repaved without the necessity for any repairs to the sewer. The incident confirmed the judgment exercised in the beginning of the work, to build the new sewers parallel to the subway of reinforced concrete.

In conclusion the author feels it necessary to recognize the fact that the matter presented does not completely comport with the title of the paper, since definite comparisons by figures of the cost of concrete and reinforced concrete for subway construction are not furnished. Reviewing the data as to the cost of subways in several cities, representing various practice, it was not found practicable in the time available for the preparation of the paper, to prepare such comparisons, since so many diverse conditions, unless carefully considered would make them of no practical value. Comparisons of the cost of modern and obsolete types have not been made, as they would be of interest only to the curious.

CORROSION OF REINFORCEMENT INSUFFICIENTLY PROTECTED.

In discussing the effect of electrolysis on metal embedded in concrete before the National Association of Cement Users, Mr. Cloyd M. Chapman also called

attention to the corrosion of reinforcement having an insufficient protecting layer of concrete. If the surface is exposed to the weather, air penetrates to the steel in dry weather and water reaches it in wet weather. The thin layer of concrete does not possess sufficient protective power to overcome the corroding tendencies of the steel. This becomes especially true after repeated rains have washed out a portion or all of the free lime in the outside layer of protecting concrete.

As an illustration of the failure that may follow the placing of steel too near the surface, Mr. Chapman showed a photograph of an exterior wall in which the steel in a few places was less than $\frac{1}{2}$ in. under the surface. The result was the corroding of the metal first at the points where the rods were nearest the surface and then the gradual extension of the corrosion along the rods, with the consequent bursting out of the concrete in which it was embedded. This building was erected about 9 years ago and the rusting of the bars and cracking out of the concrete became apparent after some 2 or 3 years. The cracking and corrosion is gradually progressing along the steel rod to where it is more deeply embedded. In time this action may lay bare the entire length of the rod.

Similar effects have followed the use of ungalvanized metal lath over which insufficient coating of mortar had been placed. In some cases large areas have scaled from outside stucco walls because the rusting of the iron lath and the consequent swelling action separated the stucco on the outside of the lath from that on the inside. Having thus lost its bond the outside stucco falls off very easily. The painting of metal lath to protect it against such action Mr. Chapman believes to be of little avail. The remedy, he stated, lies in the use of a substantial, well galvanized lath and placing on it a good and sufficiently heavy coating of dense plaster.

BUILDING CONCRETE ARCHES IN COLD WEATHER.

The Charles City Western Railway, of Charles City, Ia., has recently completed a reinforced concrete arch bridge over the Cedar River during quite severe weather. This bridge has two 95-ft. main spans and a 45-ft. span at each end. The pier that carries the adjoining ends of the two 95-ft. spans is at mid-channel and the other two at its edges. The 45-ft. spans were located so highways paralleling the river can be built under them.

The bridge was built by force account. A 500-ft. cableway was erected on the axis of the structure. A 30-hp 220-volt Westinghouse direct-current generator furnished current to operate all the plant, including the cableway, and was driven by a 45-hp Hart-Parr gasoline traction engine. The hoisting line of the cableway was operated by a single-drum Lidgerwood hoist belted to a line shaft driven by a 20-hp motor. The endless line was wound on a sheave keyed to a shaft carrying one loose and two fixed pulleys. A belt-shifting lever permitted the carriage of the cableway to be traversed in either direction. A motor-driven Waterloo concrete mixer was installed near the head tower of the cableway in a bench cut in the bank so that the charging hopper was about at the ground level on the high side, thus enabling it to be easily charged.

Bank gravel, ranging from material about $\frac{1}{4}$ in. in size down to fine sand, and Universal Portland cement

were used in the concrete. The sand and gravel were obtained from an adjacent pit. The cement was hauled to the site from a storage shed in Charles City, a distance of about 2 miles, in a train of five dump wagons drawn by a 30-hp Hart-Parr gasoline engine. This 30-hp engine hauled 15 tons of cement at a trip and averaged four round trips per day. It also hauled the timbers and lumber used in the false-work and forms. The average output of the mixer was in the neighborhood of 12 cu. yd. an hour, with nine men employed in supplying materials and removing the concrete.

Except for water in the cofferdams, no difficulties were encountered in placing the concrete for the piers and abutments. By the time the work was up to the arches, however, cold weather was at hand. Special methods in mixing and pouring the concrete for the arches accordingly were used. Provisions were made to heat the sand and gravel thoroughly and to raise the temperature of the water used in the mixing of the concrete.

Two parallel concrete walls were built in a trench, about 15 ft. long and 4 ft. wide, so as to make sides of a furnace. On these walls were laid $\frac{3}{8}$ -in. steel plates and at one end of the furnace a concrete stack was erected. This furnace when fired with wood was sufficient to warm the sand and gravel as fast as they were needed. One or two men shoveled the sand and gravel on the iron plates from adjacent piles to which the dump wagons delivered.

A 200-gal. galvanized-iron tank was set up close to the mixer for heating the water. Live steam was delivered to this tank from a steam traction engine. With this arrangement all the water necessary could be kept very hot at comparatively little expense.

Work was started on the 45-ft. arch on the opposite end of the river from the concrete plant and carried ahead successively across the structure. The arch forms were cleaned carefully before the concrete was placed, but were not heated. As soon as was practicable after each arch was poured the concrete was covered with canvas and manure to hold the heat. It was found that the heat was thus retained in the thin arch rings for several days after the concrete was placed, giving sufficient time for considerable hardening.

Mr. C. W. Hart is president and general manager of the Charles City Western Railway, and Mr. H. E. Bennett is assistant general manager.

LICENSING ASSOCIATION DISSOLVED.

Within the past month the country has been given many columns of newspaper talk about the dissolution of the so-called "cement trust." By this term is meant the Association of Licensed Portland Cement Manufacturers, which has for the past two years sought to control the Hurry and Seaman patents and to exercise a certain influence in the maintenance of prices. The official statement given out by the officers of the association in New York is very brief, as follows.

"At a meeting of the Association of Licensed Cement Manufacturers, held at its office, at 30 Broad street, it was decided by the members of that association to dissolve it, and formal action was taken for that purpose."

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The agreement under which this association was formed would have expired February 1 by limitation, and differences of opinion developed over the matter of renewing this agreement, so that the organization was dissolved a month ahead of time.

In January, 1909, the Association of Licensed Cement Manufacturers was formed with the object of improving conditions by controlling certain patent licensing agreements. The Hurry and Seaman patents, used generally in cement manufacture, were claimed by the North American Portland Cement Company, which was a merger of what is colloquially known as "The Big Six," consisting of the American, Atlas, Alpha, Vulcanite, Lehigh and Lawrence Portland cement companies.

Under the terms of this agreement all the signatory companies recognized the Hurry and Seaman patents. The members paid a royalty of 1½ cents a barrel to the North American Portland Cement Company. The country was divided by this association into two districts, the line of demarkation passing through Western New York, Pennsylvania, Maryland, and Virginia, and a different scale of prices covered each district.

The agreement affected, either as members or otherwise, these companies: Alsen's, American Portland Cement Works, Bath Portland Cement Company, Bonneville Portland Cement Company, Catskill Portland Cement Company, Egyptian Portland Cement Company, Seldersburg Cement Company, Nazareth Portland Cement Company, Penn-Allen Portland Cement Company, Pennsylvania Cement Company and the Whitehall Portland Cement Company.

The following extensive analysis of the situation as viewed by a writer on the New York Journal of Commerce will be read with much interest:

A Fight Against Competition.

"The so-called cement trust, or the Association of Licensed Cement Manufacturers, held together by the terms of a license to use certain patents controlled by one company, is going into voluntary dissolution from failure to accomplish its object of maintaining prices and profits, rather than from fear of prosecution as an unlawful combination, though the latter may have had its influence. The fact appears to be that the combination was a failure, perhaps partly because the chief monopolizing patents have been invalidated. The main object of the association was to smother competition in the making and selling of Portland cement, curtail production, maintain prices, and distribute the business equitably among the companies in the combination. It has been a fight against competition on account of overproduction which rendered a large part of the business unprofitable.

The large development in the use of Portland cement in building construction and the making of concrete for various purposes naturally gave a strong impulse to the production of the material, for which facilities were practically unlimited, but varying in the cost of production. While there seemed to be promise of large profits there was keen competition in cement-making enterprise, and many companies were formed in different parts of the country. They differed, as all industrial corporations do, in capital, skill in management and conditions of production. In other words, some were stronger financially, more favorably situated, and more ably managed than others. Unless the demand for the product was to be commensurate with the capacity established for production, some of the competitors were doomed to be crowded out in time, and the tendency to overproduction would be irresist-

ible on account of the pushing of the stronger concerns. The establishing of too great a capacity for producing the supply which the market would take at a profit for all was helped by a duty on foreign cement, which, added to a heavy cost of transportation, stimulated the effort to magnify the 'home industry.'

"The home industry was soon overdone and domestic competition began to do its work of correcting the mistake of too eager producers. Competition has a drastic way of working when it has to deal with overdoing, and the inevitable result of its operation would have been to reduce producing capacity by weeding out the feebler concerns and leaving those which could get a living profit from supplying the demand for the product. As the demand grew the producing capacity would be expanded to meet it, but the error had been committed by creating the producing capacity first beyond the requirements of an existing demand and anticipating an uncertain future. But for the tariff this might have been avoided and would certainly have been kept within safer limits, but the industry was stimulated in its infancy instead of being allowed to grow in a healthy manner.

"After it had run to unprofitable overproduction, instead of allowing a curtailment of capacity by the normal working of economic forces an effort was made to throttle the competition and prevent its treatment of the situation from being effective. The smaller companies were consolidated or absorbed, and finally an association of the survivors was formed with a view to curtailing production, keeping up a profitable price and 'equitably' distributing the business. This was not done through the device of a holding company or a trust agreement, but by making use of a patent monopoly. The Hurry and Seaman patents were in general use in making cement and the company which controlled them formed the nucleus of a combination for licensing their use by the other members, on conditions that required the observance of prices fixed by an official arbitrator of the association under a system of fines for failure to adhere to the prices. The aggregate capital of all the companies in the association is said to have been 'close to \$200,000,000.' That means the capitalization, and what relation it holds to actual capital invested or to the value of property represented is not stated. Though the patents have been held invalid, it had been part of the terms of the license agreements that their validity should be recognized.

"This combination is brought to failure by the fact that competition in making cement could not be defeated; at least, was not defeated. The business could not be monopolized by the use of patents which were not sustained by the courts. The whole industry has been demoralized and the fundamental difficulty remains that the producing capacity is too great for the demand at prices that will yield a profit to all these companies, some of which ought never to have been formed to engage in this business and could not survive under competition. The purpose is now said to be not to allow competition to do its work of weeding out the superfluous producing capacity and thereby curing overproduction, but to get up some new form of agreement to hold competition in check and keep all alive.

"The chief interest in this case lies in its illustration of a general principle in industrial enterprise. In the rapid development of a new industry, on account of a suddenly increased demand for its product, there is a tendency of capital and enterprise to rush into it for the exceptional profit that it seems to promise. Against the danger of that the only safeguard is unhindered competition from without. This is not likely to be sufficient to prevent overdoing, but when that comes

unhindered competition from within is the only cure which it is in the interest of the community to allow, and it is the best for capital and labor in the particular industry in the end. The only alternative, to save those who are involved, is a monopoly, more or less successful, to cut down production and keep up prices; and that is saving those who have made mistakes and rash ventures at the expense of the consumers of their products. Such a course has long been held to be contrary to public policy. The fight against competition is a fight for monopoly, and that is inimical to the welfare of the community."

The officers of the Association of Licensed Cement Manufacturers were A. F. Gerstell, president; Conrad Miller, vice-president; A. de Navarro, secretary and treasurer; John B. Wight, assistant secretary and treasurer.

Following the dissolution of the agreement there has been much talk of price cutting, and some net prices showing a reduction of 10 cents per barrel have been quoted. This has been done by means of an increase in the allowance for sacks from $7\frac{1}{2}$ cents to 10 cents each, the quoted price for cement remaining the same.

HOLLOW CONCRETE FENCE POSTS.

A series of experiments in the construction of hollow concrete fence posts, conducted by Prof. C. A. Ocock of the department of agricultural engineering of the University of Wisconsin College of Agriculture, has proven the many advantages of that type of post over the solid post. The economy of construction and the durability of the home made concrete fence post have been sufficiently demonstrated to the farmer, so that there is a constant demand upon the agricultural engineering department of the university for detailed information as to the construction of such posts. For three years Prof. Ocock has made and used on the college farm hollow posts, which he has found fully as strong as the solid reinforced posts, much lighter to handle, and materially cheaper in construction. It is constructed with little additional labor, and with a saving of four pounds of cement to each post.

The mixture used is the ordinary 1:2:4, which includes one part cement, two parts sand, and four parts stone, none of which is larger than will pass through a three-quarter-inch screen. The forms used are the ordinary ones, four inches wide, four inches deep, and seven feet long. For reinforcement a quarter-inch round steel rod is placed in each corner, the distance of its own diameter from the outside of the post. Each end of this rod is bent at right angles for about two inches, to anchor it firmly.

In making the hollow posts, a two-inch core composed of four pieces of wood is necessary. A central piece of wood one inch square is surrounded by four flat pieces rounded on the outer side, forming the round core. When the post is finished, the central square piece is withdrawn, allowing the four other pieces to be removed. When the core is used, the mold must have end gates with two-inch holes for the removal of the core.

For attaching the fencing to the post, the longest galvanized staples should be put in at suitable distances on one side while the concrete is soft, after the points of the staples have been spread to secure them firmly in the concrete. To fasten the fence to these staples, short pieces of No. 12 or 14 wire may be used.

The hollow reinforced concrete post, although requiring a little additional labor, saves enough concrete to offset this extra work, and at the same time is lighter to handle, and practically as strong as a solid post.

WATERPROOFING CONCRETE.

By W. Lawrence Gadd.

Hitherto all attempts to render concrete or cement work impervious to water appear to have been made in one of three directions:

1. By painting the surface of the concrete, or cement, with bituminous compounds, such as asphalt or other water repellant, the object being to prevent water coming in actual contact at all with the work.

2. The application of washes to the surface of the hardened concrete, the one wash to react with the other, with the object of filling the surface pores with a precipitated insoluble compound.

3. The addition of small quantities of insoluble substances to the cement or concrete itself, in order to fill the pores of the entire mass, or of the surface coat or rendering, with finely divided insoluble matter.

The first method needs but little comment, and includes the application to the surface of the work of any impervious material, such as pitch, tar, asphalt, presumably in a heated condition; also paint, varnishes of various kinds, and similar substances.

On the principle of method No. 2, the following applications have been tried. Sylvester's process: A hot solution of soap, prepared by dissolving $\frac{3}{4}$ lb. Castile soap in 1 gal. of water, is first brushed over and into the surface of the concrete, and allowing to dry for 24 hrs. At the end of that period a second wash, consisting of 2 oz. of alum dissolved in 1 gal. of water, is applied in the same manner. The alum solution should be at a temperature of from 60° to 70° F. The double operation is to be repeated as often as necessary or desirable, but four such coats are said to be impervious to a head of 45 ft. of water.

In "Handbook for Superintendents of Construction, etc., etc." the following cement wash is recommended for making a water-tight lining for cisterns: A stock solution is prepared of 1 lb. "lye," 5 lbs. alum dissolved in 2 qts. of water. One pint of this solution is stirred into a pail of water containing 10 lbs. of cement, and the mixture is applied to the surface of the concrete with a brush.

Another method is to apply a rendering composed say, of:

1. Portland cement 1 part; sand 1 part.
2. Portland cement 1 part, sand 2 parts, lime paste $\frac{1}{2}$ part.
3. Portland cement 1 part, sand 3 parts, lime paste 1 part.
4. Portland cement 1 part, sand 5 parts, lime paste $1\frac{1}{2}$ parts.

The surface of the rendering, composed according to one of the above formulas, is brushed with a solution of 1 lb. "concentrated lye," 5 lbs. alum and 2 gals. water, in the proportion of 1 pint of this solution to 5 lbs. of cement.

In principle the above-named methods are alike, and all depend upon the precipitation within the surface pores of the concrete, or outer coat, of insoluble alum

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soap, or hydrate of alumina, or both together. The last-named example, however, combines to some extent the method of pore-filling in bulk with sand and lime paste.

Under the heading Method No. 3, there are various processes recommended, some of which aim at filling the pores throughout the mass of the work, whilst others confine this operation to the whole bulk of the surface coat, or rendering, only.

Professor Hatt states that with a mortar composed of 1 part of cement to 2½ parts of bituminous ash, when alum and soap were mixed with the water used for gaging, the strength and hardness increased 50% and absorption decreased by the same amount. One-half of the water used for gaging was a 5% solution of ground alum, and the other half was a 7% solution of soap. The alum solution was used first.

Cunningham proceeds on similar lines. He uses powdered alum equal to 1% of the combined weight of sand and cement. To the water used in the mix he adds 1% of yellow soap.

Hawley employed a stock solution of 2 lbs. caustic potash, 5 lbs. powdered alum and 10 qts. water. A finishing coat was made with 3 qts. of this solution in each batch of mortar containing 2 bags of cement. The mortar was made with 2 volumes of sand to 1 of cement, and the work covered to a depth of ½ in.

Marsh gives the following as a waterproof coat: 2 lbs. soft soap, 12 lbs. alum, 30 gals. water per cu. yd. of the mortar. Or, 2 lbs. caustic potash, 5 lbs. alum, 10 qts. water. Of this solution 3 2-3 qts. are used for 2 bags of cement and twice its volume of sand.

It will be observed that these processes again depend upon the precipitation of aluminum soap or of hydrated oxide of aluminum, the only difference being that, in these cases, the precipitate is mixed with the mortar instead of being deposited at the surface of the hardened material.

Gaines, in a paper recently published, states that water-tight concrete can be made (1) by replacing the mixing water with a dilute solution of a suitable "electrolyte" (i. e., a 1% or 2% solution of alum); (2) by replacing 5% to 10% of the cement with dried and finely ground colloidal clay; (3) by combining methods (1) and (2). With regard to the second of these processes, the action appears to be simply one of pore-filling with fine particles of clay, inasmuch as no "electrolyte" is used; and in the other cases it is probable that the same kind of action takes place by precipitation of alumina, from the "electrolytic" solution, by calcium hydroxide, whether the electrolytic theory itself be correct or not.

It may be remarked that the use of pulverized clay for this purpose is old, but, unfortunately, no very definite conclusions as to its value, or otherwise, were arrived at.

There are on the market certain ready-prepared compounds for mixing with the concrete or cement in order to make it water-tight. Some of these will now be noticed.

"Lux," Patent No. 4,606 of 1904. This material is prepared by pouring over 100 kgs. of cement clinker (unground) 10 liters of boiling water containing 245 grains of stearine, 12 grams of potash (presumably caustic potash, although it is not clearly stated), and 10 grams of common resin. It is difficult to understand the rationale of this process, as so far as any reaction at all takes place the result would be potash salts of stearic and abietic acids, both of which are very water absorbing and soluble in water. The actual result, however, would be practically equivalent to grinding clinker with a certain proportion of tallow and rosin, plus potash, which absorbs water with avidity.

Gallagher's Waterproof Compound.—This material is to be added to cement in the proportion of 2% to 5% on the weight of dry cement before mixing with the sand and water. Its composition has been stated to be chiefly lime and magnesia, with about 3% of stearine or other fatty acid. If this material has any waterproof properties at all, it can only be (assuming the composition is as above stated) by virtue of filling the pores of the cement or concrete with finely divided lime and magnesia; and, as the amount to be added is so small, its influence in this regard would not appear to be very great.

"Pharos" Waterproofing Compound.—The composition of a sample recently examined was found to be as follows:

	Per cent.
Free fat (tallow or stearine).....	20.22
Lime soap:	
Combined fatty anhydrides.....	14.55
Combined lime	1.57
Lime	30.45
Magnesia	21.15
Hygroscopic water	3.32
Combined water	5.77
Silica	1.17
Alumina and ferric oxide	1.18
Sulphuric anhydride, etc.	.62
	100.00

"Pharos," in common with other substances of similar composition, possesses a certain amount of waterproofing action, or resistance to percolation, when mixed with a neat cement rendering in the proportion of, say, 5% on the weight of dry cement. This is partly owing to the pore-filling action of the lime and magnesia which form the bulk of the material, but probably more to the repellent action of the free grease. It is well known, however, that in process of time greasy substances in contact with water lose this repellent property to a very large extent. Furthermore, the addition of greasy substances to cement has always been regarded as detrimental to the strength and permanency of concrete, and undoubtedly does have a deleterious effect in this direction as well as producing a tendency in the work to crack. The addition of 2% of "Pharos," for instance, was found to reduce the neat tensile strain by 40%. It becomes, therefore, a question how far it is advisable to reduce the strength of concrete by such additions for the sake of an incomplete waterproofing quality.

It is possible that the best results may yet be obtained by some method of filling the pores or voids in the concrete, not necessarily with "water repellents," and to this end it is doubtless important that the character of the aggregate should be such that a minimum of voids is created in the concrete. In "Engineering Record" of January 28th, 1905, J. C. Hain emphasized this point and gave the following as a possibly ideal sand for use in concrete:

Size of Sieve.	SAND.	Percentage to pass through.
No. 8		100
Nos. 8 to 12		60.4
No. 12		39.6
Nos. 12 to 24		24.1
No. 24		15.5
Nos. 24 to 50		9.6
No. 50		5.9
Nos. 50 to 100		3.8
No. 100		2.1
Nos. 100 to 200		1.5
No. 200		.6

The same point is referred to by J. L. Davis, in a paper recently read at the Annual Convention of the American Association of Cement Users. He states that by scientifically grading the aggregate, water-tight tanks, with thin sides or walls, have been successfully built of 1:3:7 concrete; and that the results of tests carried out by himself show that a fair degree of impermeability can be secured by the use of a sufficiently fine sand, without special care in grading the coarser parts of the aggregate. Davis considers that the use of fine sand, together with crusher run stone, or ordinary gravel, as the coarse aggregate, and the usual proportion of cement, is a method of waterproofing of considerable promise. In some cases he found 1:3 mixtures to be absolutely impervious to water, at 40 lbs. pressure, when the concrete was twenty-eight days old.

It may be here remarked that concrete almost invariably becomes more impervious to water the older and harder it grows, and a mass or wall of concrete through which water readily percolates at first, may very possibly become, in the course of a few weeks or months, practically water-tight.

No doubt there are cases in which the application of external waterproofing materials (preferably on the outer, or damp, face of the work, and elastic in its character) will be useful, and perhaps necessary; but for constructional work in general, and especially basement or foundation work, conduits, etc., it is probable (as already remarked) that the problem of waterproofing concrete will be most readily solved by the simple process of closing up the pores throughout the mass of the work. Possibly fine sand alone may not be the best material, and hydrated lime appears to be useless except in small proportions; or, in other words, is not equal to the same proportion of Portland cement as a pore-filler; but experiments, not yet completed, which are being made, point strongly to the general conclusion, and show that good results in the direction of impermeable concrete are obtained by the addition of comparatively small proportions of finely divided insoluble substances.

THE EFFECTS OF CHEMICAL ACTION ON REINFORCED CONCRETE.

By H. C. Hutchins.

It has been demonstrated by numerous experiments that concrete will protect steel from corrosion. Some tests by Professor C. L. Norton demonstrating this were made by embedding specimens of steel, clean, and in all stages of corrosion, in stone and cinder concrete made with both wet and dry mixtures, and then these samples were exposed to moisture, carbon dioxide and sulphurous gases, for periods of time varying from one to three months. The steel where unprotected rusted completely away, but when protected by an inch or more of sound concrete was not affected.

It has been found that certain oils have a disintegrating effect upon concrete. The amount of the action depends upon the oil used and the strength of the concrete mixture. Tests and examinations of existing structures have been made to determine the exact effect by the laboratory of the Chicago, Milwaukee & St. Paul Railway, and the following results were deduced. Briquettes were made of neat cement, of 1:3 sand mortar, and also of 1:3 mortar of limestone screenings. These were aged four days in air and then small quantities of signal oil were applied to them, keeping

them saturated. All of the briquettes were finally disintegrated. Further tests were then made and from these the following deductions resulted:

1. Concrete mortar is penetrated by most oils and may be weakened by them.

2. Concrete is less liable to injury by oils and fats if it has been allowed to set thoroughly before being exposed to their action.

3. Oils have less effect on a good quality of concrete than upon that which is poorly mixed, porous, lean, frosted or improperly seasoned.

In ordinary use, concrete is not exposed to the action of oil except in very small quantities, so for bridges, buildings and similar structures little danger is to be apprehended. Concrete would not be advisable for structures such as oil tanks and pipe lines unless protected by a coating of tar or other suitable compound. Silicate of magnesia has been used to protect concrete from the action of oil. It is applied as a wash, and when applied the silica is liberated, filling up the pores in the concrete while the magnesium fluoate acts as a binder. The cement becomes very hard after a few months. This method has been tried in Europe with considerable success, but has the objection of being very expensive.

The action of sulphur dioxide and sulphur trioxide free from moisture will not affect concrete, but when sufficient moisture is present to form hydrous acids with the gases, the concrete will be injured, and it must be protected, either by glazed tile, a coating of tar, or other compound that will resist the action of the sulphuric acid.

When concrete tanks are used to hold soluble salts, great care must be exercised to prevent the salts from penetrating into the pores of the concrete because the salts will crystallize and crack the concrete. This may be prevented by making the inner surface of the concrete very dense with a rich cement plaster. The action of chlorine gas upon the walls of concrete ducts and chambers will be a chemical action, the chlorine and the calcium in the cement producing calcium chloride. This action may be prevented by coating the walls subject to this action with tar or acid-proof paint. If tar is used, it should be applied hot with stiff brushes and thoroughly worked into the pores of the concrete. The walls should be examined after using the structure to see that the coating of tar remains in place and all thin or weak spots should be recoated. With this coating, reinforced concrete may be used for such structures as tanks for bleach liquors and bleach chambers, thus doing away with the old type of wooden structure with a lead lining such as is now in use.

Cooling towers, built with a steel framework and lined with lead sheets suspended from the cross frames, are found to be unsatisfactory, due to the brittleness of the lead sheets. This brittleness occurs after the lead has become hardened by the action of the gases and the elements upon the sheets. When the towers sway in a high wind, the lead sheets will crack, allowing the escape of gas, or its dilution due to air being drawn in through these cracks. If these towers were built of reinforced concrete they would be much stiffer, due to the monolithic nature of their construction, and the swaying and consequent cracking of the lead would be reduced, thus lowering the cost of repairs. It would not be advantageous to replace the lead sheets by a concrete wall, as concrete is a poorer conductor of heat than lead, and the efficiency of the cooling process would be reduced.

In the construction of furnaces, reinforced-concrete walls may be used to advantage to replace common brick. While concrete should not be exposed to ex-

tremely high temperatures, especially if its aggregate is composed of limestone or granite, which are acted upon by high temperatures, it may be used for the foundations, and the side wall backing and the tops of furnaces when suitably protected from the direct action of the flames by fire-brick. In furnaces now constructed of brick, the leakage of air through cracks in the brickwork causes serious losses of heat by the admission of air above the furnace grates, thereby cooling the gases before they pass the boiler tubes. Reinforced-concrete walls may be so designed that the cracks, caused by the expansion and contraction due to the heat, can be minimized, thereby reducing the leakage of air through the wall. The non-conductive properties of concrete would also make it a good insulating medium, and the wall could be made hollow with air spaces to increase its insulating value.

Considerable trouble is experienced by the action of sea-water on concrete. The subject has been studied by many investigators and many essential facts have been discovered. The use of fine sand in the concrete has been found to be very injurious, as the continuous filtration of the sea-water will decompose and wash away the grains of fine sand, while coarse sand will remain in place, because of its sharp edges. It should, therefore, be used exclusively.

The decomposing action of salt water on hydraulic cement is due to the presence of sulphuric acid combined as a soluble sulphate, and is also affected by the magnesia present in the water. The addition of gypsum to regulate the setting of the cement should not be allowed in any cement used where exposed to salt water, as it will be acted upon. The percentage of aluminum should be as low as possible, as the sulphates present in the sea-water will combine with it. It has also been found that the cements richest in lime are acted upon most rapidly by the sulphates present. The most desirable cement for use in structures exposed to the action of sea-water must therefore have a low percentage of lime and must also be low in aluminum. If materials are mixed with the cement that will produce insoluble compounds with the lime, the value of the cement will be increased. An excellent material for this purpose is puzzolana, or volcanic ash. Experiments have been made, using this material, and it has been found to improve the ability of the cement to withstand the action of sea-water.

A good method of preparing the concrete to resist the action is to make the mixture very dense, so that the sea-water will be prevented from penetrating.

Various substances may be used to render the mortar more efficient in resisting the penetration in its outer layers. Sesqui-carbonate of ammonia from gas liquor may be applied with a brush or as a spray to the surface of the concrete. When it dries it converts the hydrate of lime to carbonate of lime, which is not acted upon by the neutral sulphates present in the sea-water.

Magnesium fluosilicate may be used, which converts the free lime into calcium fluoride and silicate of lime, which close up the pores of the mortar in connection with the liberated hydrate of magnesia.

Barium chloride, in amounts of 2 or 3% of the weight of the cement, may be used by dissolving it in the water used for mixing the concrete. Insoluble barium sulphate is formed by the chemical action with the active sulphates present in the sea-water, while the magnesia remains in the solution as magnesium chloride. This causes the pores in the concrete to close, and it need therefore be used only in the exterior portion of the wall.

Cement plaster is used for protecting the steel salt pans, used in the manufacture of salt, from corrosive

action of the hot solutions contained. The inner surfaces of sulphite digestors for paper mills are also coated with neat cement, which protects the iron from the action of the dilute sulphuric acid.

Cement paints are being used a good deal, and have given very satisfactory results.

Reinforced concrete is being put to new uses in connection with the chemical industries, but owing to the secrecy with which all such concerns are surrounded, the amount of information available is very slight. This is probably a slight advantage to the individual companies, but it certainly retards the general growth of the chemical industry.

INFORMATION WANTED CONCERNING TREATMENT OF CONCRETE SURFACES.

A report has recently been issued by the committee on exterior treatment of concrete surfaces of the National Association of Cement Users, of which Mr. Leonard C. Wason, of the Aberthaw Construction Co., is chairman. It is the wish of the committee to obtain additional information from manufacturers, engineers and users of appliances and materials for coating concrete surfaces. Any information in regard to the above would be very much appreciated. Correspondence in regard to same should be addressed to Leonard C. Wason, President of the Aberthaw Construction Co., 8 Beacon St., Boston, Mass.

REINFORCED CONCRETE PIPE.

A pamphlet published recently by the Reinforced Concrete Pipe Company, of Jackson, Mich., gives the results of a series of tests conducted at Dorranceton, Pa., on the company's 24-in. pipe for the main sanitary outlet of that borough; the tests were made by Messrs. Smith & Wells, consulting engineers, Wilkes-Barre, Pa. The pipes were each 36 in. long and the shell $2\frac{1}{2}$ in. thick, the gravel concrete mixture being 1:2 $\frac{1}{2}$:5. The pipes were buried one-half their depth and loaded with steel sheeting carried by cradles cushioned on the pipe surface with burlaps. The first pipe was one 30 days old which had been condemned on account of longitudinal cracks; it sustained a load of 18,326 lb. at failure. The second test was on an 18-day old pipe; a loading of 13,544 lb. developed hair cracks at top and bottom. Failure occurred at 26,160 lb. The third pipe tested was 30 days old; at 12,800 lb. hair cracks appeared, and failure occurred at 35,997 lb. The Reinforced Concrete Pipe Company is also distributing a set of specifications for reinforced concrete pipe which it recommends for most purposes.

REMARKABLE TEST ON CEMENT DRAIN TILE.

A cement drain tile cast in 1883 and in service for twenty-three years from that time was the subject of an interesting test at the Cement Show. The tile was recently taken from the farm of Mr. Howard Fitz at Monterey, Minn. It was four inches in diameter, eleven and three-quarters inches long, with a wall thickness of one and one-half inches and not different from hundreds of others that are still serving as an efficient drainage system.

A 60,000-pound Olsen compression machine was used for the test. The tile was imbedded in plaster between two wooden saddles, one above and another below, each covering one-third of the area.

Estimates of the tile's breaking strength were varied, but few believed the tile capable of the load actually borne before breaking.

The tile gave way at 31,220 pounds—more than fifteen tons. It showed the remarkable strength that may be expected from well made tile and also the fact that cement tile does not deteriorate with age, as this specimen had seen twenty-three years of service.

CRUSHED GRANITE FOR BEST CONCRETE.

Many a job of Concrete that stood for a while, and then went to pieces, has caused loss and delay for which the Cement or the workmanship was blamed, when the facts were that the failure was due to the softness or unclean condition of the stone or gravel used, and it has been demonstrated time and again that the softer stones constantly sheer and disintegrate with the growing strength of the Concrete as it ages, causing voids and lines of weakness, and as a result, the Cement has nothing to hold to, writes the Wisconsin Granite Co., of Chicago.

Where durability, and severe conditions of load, strain or vibration are factors, or where immunity against the effects of smoke, moisture, gas or acids is desired, a concrete of CRUSHED GRANITE insures strength and permanency with no greater expense for labor and Cement that constitute the main cost.

Quarried from ledges, it is clean, broken stone, properly screened and sized (no field stone or boulders in it) and the Northern granites are the hardest and strongest known, containing upwards of 70 % Silica or Quartz.

It is made in seven sizes, ranging from 2¼ in. down to dust; can be furnished promptly at very reasonable prices, and samples and prices can be had upon request.

BUREAU OF CEMENT CONSTRUCTION.

The plant of the Inland Portland Cement Company, situated at Metaline Falls, Washington, is now rapidly nearing completion.

With the advent of this company into the western cement field, coming as they do with many years of practical experience in the manufacture of Portland cement, will come a cement that can be depended on in every particular.

It is the desire of this company to give the knowledge it has gained by long experience to the cement users of the Northwest, and to carry out this program it is the intention to open a bureau of information on cement construction as soon as the mill is in operation.

Many readers of Cement & Engineering News who are in the cement business in the Inland Empire may anticipate receiving a call from a representative of the company in the near future.

FACTORY BUILDINGS—MINNESOTA STATE PENITENTIARY.

At the Minnesota State Penitentiary at Stillwater there are being built several factory buildings that are interesting both in design and in method of construction. The interior view shows an unusual form construction. In place of lumber sheeting for the ceiling forms, there was used corrugated sheet steel. This may be used many times, and where several floors are to be built, it effects quite a saving.

The motors are about to be raised to the ceiling for inverted suspension. The pipe framework will support a walk the full length of the room. The other pictures show various stages of the work and the end wall of a previously completed reinforced concrete building.

CEMENT MILL NEWS.

Rufus Merriam has been selected as secretary of the Acme Portland Cement Company, succeeding E. C. Hadley, the former secretary, who died about a month ago.

Ten thousand dollars in improvements is being expended by the Nephi Plaster & Mfg. Co., of Nephi, Utah. These improvements will double the present capacity of the plant.

The Ogden Portland Cement Company reports a most healthy business for the past year, as the plant which is located at Brigham City, Utah, has been running night and day ever since the opening. The company expects to install a large steam power plant, as they have been unable to receive the power desired from the Brigham City electric plant.

The Newaygo Portland Cement plant at Newaygo, Mich., have resumed operation after a shut-down of two months.

The sale of the United States Cement property at Bedford, Ind., has again been postponed by an agreement among those interested. The plant was sold some time ago at commissioner's sale, but by an agreement the sale was ordered set aside.

The plaster mill of the Albert Mfg. Company at Hillsborough, N. B., Canada, was burned to the ground, throwing 100 men out of employment.

The Inland Portland Cement Company of Spokane, at a recent meeting, increased its capital stock from \$1,000,000 to \$1,500,000, and notice of same was sent to the Secretary of State.

An application has been made by the Balfour-Guthrie Company, Seattle, Wash., who are about to erect a big cement plant at Bellingham, Wash., for the purchase of 1,000,000 feet of timber. Just for what purpose this enormous quantity of lumber is being purchased is not known nor has any announcement been made as to the amount of money involved.

The plant of the Southern Wall Plaster Company, Louisville, Ky., was destroyed by fire, March 10th. The loss was \$8,000. E. J. Kollros is manager of the company, which will rebuild.

The annual report of the Canada Cement Company, general offices, Montreal, Canada, for 1910, contains an item of considerable interest: In addition to the operation of its nine plants in Canada, the company have decided to erect another plant at Winnipeg.

It is reported that John Legart of New Albany, Ind., is interested in the construction of a Portland cement plant, to be erected near Bowling Green, Ky.

The Piedmont Portland Cement Company have just completed their new cement plant at Aragon, Ga. The capacity will be 600 barrels daily, but this will be increased in a short time. The capital of the company is \$400,000. The officers are: J. C. Bass, president, Carrollton, Ga.; W. H. Davis, secretary-treasurer, Atlanta, Ga.; S. W. Palmer, vice-president, Millen, Ga., and Wm. S. Davis of Hamden Junction, Ohio, is superintendent.

NEW METHOD OF LAYING RAILS IN CONCRETE.

The "Electric Railway Journal" says that Dr. M. Eisig, manager of the Chemnitz, Germany, municipal street railway system, has recently designed a novel construction for rigidly anchoring in a reinforced concrete base rails laid in paved streets. The anchorage consists of iron rods $\frac{3}{4}$ -inch to $1\frac{1}{8}$ -inch in diameter and from 20 inches to 24 inches long passing through the web or the base of the rail from 6 inches to 8 inches apart and embedded in the concrete girder which surrounds the rail below the head. These rods are securely fastened to the rail by conical channel pins and are bent down at the ends to secure a firm hold in the concrete. The rods not only tie the rail to the concrete, but also serve as lateral reinforcement in the concrete beam. Additional reinforcement can be used by placing longitudinal rods in the concrete beam parallel to the rail and tying the two sets of rods together with wires at the points of intersection. The resistance to lateral motion of the rail under this construction is increased by inserting the transverse rods through the web of the rail close under the head. The distance between the top of the head of the rail and the centre line of these rods depends on the depth of the paving and the thickness of the layer of concrete above the rods. The adhesion of the concrete to the rail and the rigidly attached reinforcing rods prevent any movement of the rail relative to the concrete beam, and thus there is no grinding or pulverizing due to the rail working loose under vibration.

THE PORTLAND CEMENT PRODUCTION.

in the United States in the year 1910, according to the preliminary estimate made by Mr. E. K. Burchard, of the United States Geological Survey, has set a new high record. His preliminary estimate is based on statistics and estimates received by the Survey from 20 per cent of the companies manufacturing Portland cement, these companies representing nearly half of the entire output of the country. From these figures he concludes that the production in 1910 was between 73,500,000 and 75,000,000 bbl., as compared with 63,508,471 bbl. produced in 1909. This is an increase of 10,000,000 to 12,500,000 bbl., or 15 to 20 per cent. The figures on which this estimate is based have been received from manufactureres in all parts of the United States, and are therefore considered to be representative of the country at large rather than of any single section or district. Although the average values for 1910 appear, from returns received thus far, to have been slightly higher than in 1909, prices were far from satisfactory, especially to the large manufacturers in the Lehigh Valley district and in certain of the Eastern States. The year 1911 opens with prices cut 5 to 10 cents a barrel lower than those prevailing in 1910. The construction of several new plants has been pushed during the year, and several plants that were under construction in 1909 became producers in 1910, so that the kiln capacity remains far in advance of the demand.

On May 1st, 1911 the office of Cement & Engineering News will be removed to.

1117 Schiller Building, Chicago, Ill.

Tel.: Randolph 934.

The new plant of the United States Gypsum Company at Fort Dodge, Ia., will be in full operation by April 15th. Some parts of the plant are now running, but there are some small details of construction which will take a few weeks to complete.

The Thomas Millen Co. have completed the construction work on their new cement plant at Jamesville, N. Y.

The International Portland Cement Company has been organized with a capital stock of \$3,000,000, for the purpose of erecting a large cement plant near Spokane, Wash. J. S. Irvin of Ottawa, Canada, is president.

Some time during the coming spring the Hawkeye Portland Cement Company, R. A. Long Bldg., Kansas City Mo., will build a cement plant at Mason City, Iowa, where the company owns about 700 acres of land.

It is reported that the Freeborn Engineering & Construction Co., Kansas City, Mo., have secured the contract to erect a Portland cement plant at Pinehill, Ky., to have a daily capacity of 1,600 barrels of cement.

The Atlantic & Gulf Portland Cement Company, which recently built a cement plant at Ragland, Ala., may decide to erect another plant at Ashville, Ala.

LEHIGH COMPANY MOVES TO CHICAGO.

The Indianapolis offices of the Lehigh Portland Cement Company, up to date the headquarters of the company, will be closed April 24, with the exception of a small branch office, which will henceforth be maintained at Indianapolis in the Traction Terminal Building. This office will be in charge of H. L. Scott. Another branch office will be opened in the Memphis Trust Building, Memphis, Tenn., in Charge of S. J. Moss.

After the 24th of this month the main office will be in Rooms 521-529 People's Gas Building, Chicago. The entire office force will be brought to Chicago from Indianapolis, and further strengthened by the addition of 12 or 15 more employees. Fred E. Paulson will have entire charge of the sales and traffic departments and W. E. Viets will be head of the financial and accounting end.

CHARLES F. McKENNA, Ph. D.

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It has not been fully decided by the company whether to maintain their present office at Cleveland, or move same to Columbus. This question will be decided on very shortly.

LINK-BELT CO—BOSTON OFFICE.

To properly take care of the increasing demand for "Link-Belt" elevating, Conveying and Power Transmission Machinery and Chains, the Sales Office of the Link-Belt Company, formerly located at 84 State Street, Boston, Mass., has been moved to more commodious quarters at 131 State Street, Boston. Mr. Lawrence Spillan is in charge.

BOOK REVIEWS.

The fifth annual edition of the "Directory of Portland Cement Manufacturers," for the current year, has just appeared. The purpose of the compiler is to present a complete list of manufacturers of cement, giving a statement in connection with each producer of the location of the main offices and works, the officers, the capitalization, the capacity and the number and size of the kilns. There are also lists of brands of cement, of gypsum companies, lime companies and an alphabetical list of the officers, superintendents and chemists of cement companies. (Chicago, 1207 Morton Building, Cement Era, \$1.00.)

LIME KILNS.

A recent publication on Lime Kilns and Lime Burning Equipment issued by the IMPROVED EQUIPMENT CO. of New York City describes in an ex-

haustive and very interesting manner the various types of lime-kilns built by this company.

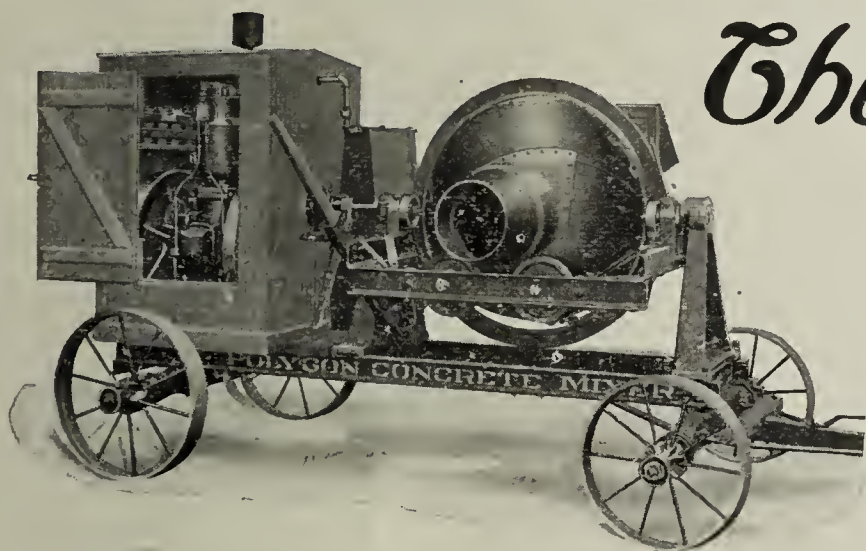
Numerous cuts accompany the pamphlet, which deals with the principles of lime burning, the use of coal and of producer gas for burning and points out the advantages and economies of the various systems.

As the firm is composed of designers and builders of gas producer power plants, water gas plants and of special furnaces for industrial purposes, the reader looking for information on these subjects will find much valuable news in their publication.

MEDUSA WHITE PORTLAND.

The Sandusky Portland Cement Co. has been the first concern in this country who experimented with white Portland cement materials on a large scale. After 10 years of extensive efforts in this line, they now manufacture a Portland cement which contains less than one-half per cent of iron oxide and which is practically white, if exposed to the atmosphere for a sufficient length of time.

The advantages of this white Portland cement over the ordinary gray Portland are apparent, especially if it is to be used for exterior decoration, where the gray cement soon assumes an unsightly appearance on account of the white efflorescence forming on its surface. Architects, therefore, prefer white Portland to common Portland cement for all ornamental work. To what extent this is true, can be seen from the illustrated catalogue of the Sandusky Portland Cement Co., which contains a great number of cuts showing the outside of buildings, interior decoration and statuary made of Medusa White Portland Cement. The pamphlet may be obtained free of charge by writing to the Sandusky Portland Cement Co., Sandusky, Ohio.



The POLYGON

Concrete and Mortar Mixer

Quickest

Most Efficient

Most Durable

Hence most economical—the Mixer of **Biggest Earning Power**. Charges, mixes, dumps—concrete or mortar—wet or dry, fine or coarse, in **one-half** the time taken by other Mixers of same size drum—

A TEST—READ IT

Two years ago I was looking for a concrete mixer and saw your cut in the paper. I immediately made up my mind that it was the very kind of a mixer that I wanted, so I sent in my order. The first trial I gave your mixer was to place 5 cu. ft. of sand in it and 2 lbs. of red mineral color, and in just a few seconds the sand was completely mixed with the color. With that test I was satisfied that the Polygon will mix and do it right.

I have mixed all kinds of sands, from quick-sands to boulders, but have never seen a mixer which suited me better or gave more satisfying results than the Polygon.

GEO. E. BETZLER, Minneapolis, Minn.

Dumps a Batch of Unassailable Uniformity

Built by Specialists; used by Experts; endorsed by Government Engineers and eminent contractors. It's all in the Drum—it's the drum that "does the business." The Polygon is the only Drum with the scientific "Mixing Motion."

Write at once on your business letterhead for 1911 Catalog.

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POPULAR HAND BOOK FOR CEMENT AND CONCRETE USERS.

The Popular Hand Book for Cement and Concrete Users, by Myron H. Lewis and Albert H. Chandler, is an excellent book of reference for the practical man who desires to study the best methods of mixing concrete and of using it. The various tools and designs of forms for ornamental work are described in simple language and fully illustrated. Concrete block construction, concrete in railroad construction, concrete on the farm and waterproofing of concrete structures are several of the most interesting chapters of this publication. 420 pages. Price \$2.50.

THE CHEMISTRY AND TESTING OF CEMENT.

The Chemistry and Testing of Cement, by Cecil H. Desch, may best be termed the first comprehensive review, written in the English language, of the research work done by the numerous cement chemists who tried to explain the constitution and the hardening process of cements.

The writer, on account of his knowledge of the English, German and French languages, is able to give an interesting resume of the most important essays published during the past 80 years, which time we may consider the period of scientific research of cement materials. The publication is up-to-date in every respect, embracing even the latest researches of the Carnegie Institution. 266 pages. Price \$4.00.

TRADE PUBLICATIONS.

"Pittsburgh Standardized Reinforcement" is the title of an elaborate handbook for the design of reinforced concrete structures. This handbook, to be known as the "Blue Book," is now being distributed by the Pittsburgh Steel Products Company, Frick Building, Pittsburgh, the manufacturers of the material. The book is of "pocket" size, $4\frac{1}{2} \times 6\frac{1}{2}$ in., contains 400 pages, and on general lines bears a close resemblance to structural steel handbooks. The tables and other data were prepared by a large corps working under the direction of Mr. Wm. Barclay Parsons, consulting engineer, New York. All girder, beam and slab tables are figured on the basis of the "straight line" formula, using a maximum tensile stress of 16,000 lb. per square inch in the steel and a maximum compressive stress of 650 lb. in the concrete. The bending moments at the middle beams were taken at $w/2-10$, and all reinforcing frames were designed with at least 25 per cent as much steel over the supports as at the middle. The formulas given in the Joint Committee's report were used on the computations. It is impossible in a brief note to enumerate the various classes of tables in the book. There are safe live load tables for T-beams, with various thicknesses of slabs, spacing of beams and spans; tables of safe uniformly distributed total load for T-girders of different depths; floor slab tables; rectangular beam lintel, and column tables, and quite a variety of tabular matter of a general character useful to the designing engineer. In the last classification are tables of timber strength, weights of materials, squares, cubes, roots and reciprocals. The explanatory matter on the method of designing reinforced concrete beams and slabs and of the uses of the tables is quite detailed.

VALUABLE BOOK FOR ADVERTISING AND BUSINESS MEN.

The most interesting and useful book on the subject of advertising that has ever come to our attention is the 1911 edition of the Mahin Advertising Data Book. It is neatly bound in leather, and though of vest pocket size, it contains over 500 pages and is crammed with useful information and data pertaining to advertising and selling.

This book contains detailed information on all the important magazines, newspapers and other periodicals published in the United States, Canada and West Indies and the Phillipines, classified and arranged for instant reference.

It also gives population of towns in the United States where daily papers are issued, and shows in dollars and cents the cost of posting each town that is listed.

A great improvement in this the eleventh edition over former issues is that detailed information is given on the 357 trade publications, all arranged under the several classifications.

The large amount of reliable statistical matter, much of it from the 1910 census, arranged especially for quick use by the advertiser, Mr. John Lee Mahin's Ten Tests of an advertisement, and the various authoritative treatises on the subjects of Type, Color, Printing, Plates, Posting, Paper, Copyrights, Trade-marks, and Patents, etc., make this a complete and indispensable companion for the up-to-date advertising and business man.

Any reader of this may have ten days free use of the Mahin Advertising Data Book by writing to the Mahin Advertising Company, American Trust Bldg., Chicago. If you don't want to keep the book, return it at the end of ten days. Otherwise, send in \$2.00 and the Mahin Messenger will be sent without further cost for 12 consecutive months.

WILLIAMS PULVERIZER COMPANY.

The Williams Disintegrator or Crusher, manufactured by the Williams Patent Crusher & Pulverizer Co. of St. Louis, Mo., is fully described in a publication recently issued by the company.

The various types of this machine have been extensively used for the past 15 years at cement plants for grinding limestone, shale and coal, and are too well known to need further comment.

For the prospective cement manufacturer, therefore, who wishes to familiarize himself with the details of the best grinding machinery on the market, this booklet seems to be especially written. It points out the advantages of the wearing parts of the machine, describes the output of the various types, and gives a long list of manufacturers using it, among which hardly a cement plant or lime company in the country is missing.

MOTION STUDY.

Motion Study, a Method for Increasing the Efficiency of the Workmen, is the title of a clever booklet written by Frank B. Gilbreth, giving advice to bricklayers and illustrating on numerous cuts the proper and faulty methods of handling brick and mortar and of making the best use of the tools employed in the profession. 116 pages. Price \$2.00.

CEMENT

... AND ...

ENGINEERING NEWS



CHEESMAN MEMORIAL, DENVER, COLO. Cost \$100,000.00.

Entire Substructure made of Medusa White Portland Cement, Furnished by Sandusky Portland Cement Co., Sandusky, Ohio.

Mareau & Norton, Architects.

McPhee & McGinnity, Contractors.

CEMENT AND ENGINEERING NEWS

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JOHN F. WALDRON

Advertising Manager

Chicago, May 1911.

CONCRETE ON THE FARM.

The wide-spreading application of concrete which has brought about many radical changes in the building industries on the American Continent has benefitted hardly any class of men more than the farmer, who is to-day one of the most willing and most ambitious followers of the interests which have at heart the proper and extensive use of cement.

A great deal of valuable information about improving farm property can be obtained by addressing the Universal Portland Cement Co. of Chicago or the Vulcanite Portland Cement Co. of New York whose publication "Concrete In The Country" describes in detail

plant in the country from which, after harvesting time is over, farmers can not be seen hauling cement all day long.

His first experiment, which probably consisted in laying a narrow concrete walk in front of the house, succeeded so well that he is encouraged to go on with his improvements. The yard walk is extended to the barns and outlying buildings. Wading through seas of mud and resulting tracked-up kitchen floors become a thing of the past. By simply increasing the width of the walk, a cellar floor is provided and the farmer has a dry cellar. This is so clean and so odorless that he considers such a floor fit for that most immaculate of all places—the milk house.

After a little more observation, he quits digging deep cistern-pits, with the necessary annoyance of thawing out frozen pumps and carrying water—he builds a concrete cistern on top of the ground and makes the pumping and carrying of the water a mere matter of turning a faucet in the kitchen and the bath room.

Thus the conservative farmer of the present time gives careful attention to the health, comfort and convenience of his family. Moreover, the care of the animals is not neglected. Many farmers had tried wooden feeding floors and had found them a paying proposition as far as the saving of feed was concerned, in the general health of the animal, and in the shortened time of fattening. But two great drawbacks were the rats that infested them and the constant need of repairs. In concrete the thoughtful farmer saw the possibilities of an ideal floor—an easily cleaned, rat-proof, disease-proof surface upon which his hogs, sheep, cattle and poultry might consume the feed even to the smallest particle.



A Circular Concrete trough built at the Connecticut Agricultural College for the Use of Cattle.

all the various uses to which cement can be put on the farm, at the same time giving full instructions on properly proportioning and placing concrete and on forms, metal reinforcing and whatever tools may be needed in the work.

Clean sand or gravel is the only thing the farmer has to look for. All other materials can be obtained from a dealer at the next country town. If a cement plant is located in the neighborhood, he will buy his supply of cement directly from the mill, and there is no cement

So satisfactory did the feeding floor prove that the same treatment suggested itself as a remedy for the fly-breeding, muddy holes in the earthen floors and the rat-infested wooden floors of the barns.

The continual rotting off of wooden fence posts, the constantly increasing cost of new ones, and the annual expense of fence repairs, called for the introduction of some substitute. Land is entirely too valuable and life too short to attempt growing wooden posts. Even before the telephone and telegraph companies had

thought of the possibilities of concrete in this line, a few venturesome farmers had given reinforced concrete posts a trial and found their use not only advisable from the standpoint of cheapness in first cost, but more profitable on account of their everlasting qualities. The Department of Agriculture at Washington has thoroughly investigated the use and methods of making concrete posts and is furnishing a free bulletin describing the process.



A Concrete Watering-trough made by A. L. Saylor on his Farm near Sylvia, Kansas.

This trough is oblong in shape, and the concrete shows the marks of the forms on the outside. It will be noted that the trough is placed on the fence line between two fields, so that animals pasturing in either of the fields have access to the trough.

The use of concrete in farm buildings has gradually developed from the ground upward. The drip soon rots out timber near the ground and eventually crumbles away the brick foundation. At first, uselessly making the walls as heavy as those of brick, the farmer gave concrete a trial in foundations. Concrete is stronger than brick. As a wall it kept the basement and bank barn dry. The height of the foundation wall increased until it supported the joists of the hay loft.



The Concrete Skim Milk Vat in the Piggery of the Connecticut Agricultural College at Storrs, Conn.

The tank is divided into three sections, one of which is used for cooking vegetables by steam; the other two for skim milk. After the milk is skimmed and ready for feeding, it is drawn into pails by means of the two gate valves which are shown in the cut.

Finally, after a study of methods of reinforcing, the entire barn—basement, walls, floors, mangers, troughs, gutters, beams and even the shingles—became concrete. Matches or lanterns accidentally dropped on concrete floors in concrete barns do not cause the terror of former times. The oil will burn until smothered out with a horse blanket, but no further damage will be done.

Poultry raising on many farms has become well-nigh impossible on account of rats. To free the farm of these destructive animals, as a last resort and in spite of the assertions that the grain would spoil, the thoroughly provoked farmer put concrete floors under his cribs and granaries. Corn matured enough not to spoil on other floors kept perfectly on concrete. The rats had to go; they could not get through such floors. And so we might continue, describing how farmers have successfully used concrete in building every class of structure from a stepping stone to the entire group of farm buildings.

Just as there are right and wrong methods of farming, so, too, are there right and wrong ways of using concrete. It is the aim of the literature published by the companies mentioned in the foregoing to give such directions and informations as will enable the reader to build with concrete safely and successfully.

SAND-LIME PRODUCTS.

By E Leduc & Ch. de la Roche.

(Continued from page 148.)

The Nature of the Sand.

From a chemical standpoint, there exist three different kinds of sand: siliceous sand, argillaceous sand and calcareous sand. The chemical composition of sand-lime products, which proved them to be made of sand grains cemented together by hardened calcium silicate, as well as the results obtained by the following tests, showed plainly that siliceous sand should be used exclusively.

Argillaceous Sand: The advisability of an admixture of clay to sand, or in other words the application of an argillaceous sand, has been discussed for a long time, especially in Germany.

Certainly, the clay is attacked and decomposed by the lime under the conditions prevailing in the manufacture of sand-lime products. This can readily be proven by subjecting a compressed mixture of clay and hydrated lime to high-pressure steam and subsequently decomposing the resultant product with a strong acid. The acid precipitates a large amount of gelatinous silica.

From this reaction the conclusion may be drawn that it would be advantageous to either add clay to a sand-lime mixture or to make use of argillaceous sands.

In order to throw some light on the subject, we prepared several series of sand-lime mixtures with and without admixtures of clay, the results of which are given in table VII.

These experiments demonstrate that there is no advantage in adding 10% of clay, that is to say, in our case, an amount equal to that of the lime. The average compression strength was for mixtures with and without admixtures 1828 lbs. against 1762 lbs., 1837 against 1930 lbs. and 2306 against 2312 lbs.

A larger admixture, namely 20% resulted in increased strength 2259 against 1762 lbs.; however, the admixture of so large a proportion of clay is prohibitive, because it greatly increases the cost of manufacture.

TABLE VII.
Effect Of An Admixture Of Clay.

Hydrated Lime in percent by weight	Clay passing 180 mesh sieve in percent	Sand in percent by weight	Initial Compress- ion of Mixture in lbs per sq. in.	Steam Pressure in lbs	Time of Exposure to Steam in hours	Resistance to Compression after hardening given in lbs per sq. in.				Average
10	—	90	3.750	150	6	1.830	1.620	1.725	1.875	1.762
10	10	80	"	"	"	1.800	1.875	1.837	1.800	1.828
10	20	70	"	"	"	2.250	2.287	2.287	2.213	2.259
10	—	90	3.750	120	6	1.830	1.762	2.100	2.025	1.930
10	—	90	7.500	"	"	2.362	2.287	2.273	2.325	2.312
10	9	81	3.750	120	6	1.725	1.875	1.800	1.950	1.837
10	9	81	7.500	"	"	2.325	2.250	2.325	2.325	2.306
10	18	72	3.750	120	6	2.625	2.625	2.625	2.700	2.644
10	18	72	7.500	"	"	2.775	3.075	2.850	3.150	2.962

It was, therefore, of interest to determine, whether it was preferable to replace the clay by finely ground sand, which would be more easily attacked by the lime.

For this purpose, we prepared a series of test pieces composed of sand-lime mixtures without admixture and several sets to which various amounts of clay were added, and others to which an equal admixture of ground sand was made of the same fineness as the clay, that is to say, likewise passing the 180-mesh sieve. The results are recorded in table VIII.

These tests prove beyond doubt that an admixture of fine sand is preferable to an admixture of clay, as

delusion; for thorough mixing of the materials becomes extremely difficult in the presence of so much clay.

In our experiments it was comparatively easy to obtain a perfect mixture, as we worked with materials that were previously dried. But, in practice, where the sand is never uniform and, moreover, moist, serious difficulties are encountered, because the lime has no access to the sand grains which are coated with the clay dust. For this reason argillaceous sands should never be used.

In order to demonstrate if a perfect mixture was really as difficult to obtain as we supposed to be the

TABLE VIII.
Comparison Of Admixtures Of Clay And Fine Sand.

Hydrated Lime in percent by weight	Sand in percent by weight	Fine Sand passing 180 mesh sieve in percent	Clay passing 180 mesh sieve in percent	Initial com- pression of mixture lbs	Steam pressure in lbs	Resistance to Compression after hardening given in lbs. per sq. in.					Average
10	81	9	—	3.750	120	6	3.525	3.750	3.525	3.450	3.562
10	72	18	—	"	"	"	4.425	4.500	4.350	4.275	4.387
10	81	9	—	7.500	"	"	3.675	3.900	3.750	3.675	3.750
10	72	18	—	"	"	"	5.100	5.400	4.950	4.875	5.081
10	81	—	9	3.750	"	"	1.725	1.875	1.800	1.950	1.837
10	72	—	18	"	"	"	2.625	2.625	2.625	2.700	2.644
10	81	—	9	7.500	"	"	2.325	2.250	2.325	2.325	2.306
10	72	—	18	"	"	"	2.775	3.075	2.850	3.150	2.963
10	90	—	—	3.750	"	"	1.838	1.762	2.100	2.025	1.931
10	90	—	—	7.500	"	"	2.363	2.288	2.288	2.325	2.316

the crushing strength of the test pieces containing fine sand is far in excess to those made with clay.

The fact that an admixture of 20% of clay gave superior results (see table VII), might be interpreted as being in favor of argillaceous sand; however, the experiments described in table IX show that this is a

case, we worked with 5 argillaceous sands of different origin, in which the clayey substance was determined in advance by levigation. The contents of clay were brought up to 20% in all sands by adding the missing percentage in the form of finely powdered clay. The mixture of sand and clay was then transformed into a

thin mud by the addition of water and mixed thoroughly in this state. Afterwards it was dried out so that an argillaceous sand resulted which contained from 8% to 10% of moisture and 20% of clay substance. The sand-lime mixture was prepared, as usually, by weighing off 90% by weight of the argillaceous sand (figured upon dry material), 10% of hydrated lime and adding about 10% of water.

The results are to be found in table IX.

Calcareous Sand: For studying the consequences

Another set of test pieces which was moulded under 7,500 lbs. of pressure and which contained 20% of hydrated lime, behaved better, as table X shows.

These experiments prove that the application of sand with a noticeable amount of limestone is objectionable, as the larger percentage of hydrated lime required in this case increases the cost of manufacture so as to render the process impracticable.

Hence, the conclusion to be drawn from all these

TABLE IX.
Argillaceous Sands Containing 20 % Of Clay Substance.

Marks of the various Argillaceous Sands used	Hydrated Lime	Sand free of Clay	Argillaceous Sand containing 20% Clay	Initial Compression of mixture in lbs.	Steam Pressure in lbs.	Time of Exposure to Steam in hours	Resistance to Compression after hardening in lbs. per square inch				Average
A.	10	90	—	3,750	120	6	1.838	1.763	2.100	2.025	1.932
	10	90	—	7,500	"	"	2.363	2.288	2.288	2.325	2.316
	10	—	90	3,750	"	"	1.688	1.650	1.470	1.515	1.581
	10	—	90	7,500	"	"	1.988	1.988	1.778	1.725	1.870
B.	10	—	90	3,750	"	"	1.388	1.320	1.530	1.440	1.419
	10	—	90	7,500	"	"	1.710	1.748	1.590	1.838	1.721
C.	10	—	90	3,750	"	"	1.328	1.170	1.230	1.380	1.277
	10	—	90	7,500	"	"	1.590	1.718	1.530	1.567	1.601
D.	10	—	90	3,750	"	"	1.680	1.530	1.500	1.470	1.545
	10	—	90	7,500	"	"	1.710	1.890	1.680	1.650	1.732
E.	10	—	90	3,750	"	"	1.320	1.448	1.260	1.230	1.314
	10	—	90	7,500	"	"	1.530	1.568	1.530	1.688	1.579

of the application of a calcareous sand, we carried on the same tests as for the clay, but replaced the clay by finely powdered marble passing the 180-mesh sieve.

The first series of tests which we prepared contained, in addition to the usual 10% of hydrated lime, 10% and 20% of marble dust and were compressed under a pressure of 3,750 lbs. However, this pressure did not prove to be sufficient. The sand-lime mixture containing so large a percentage of inert material did not possess enough cohesion and fissured or disintegrated completely upon being subjected to the hardening process.

tests is that, for practical purposes, the purest silica sand is the best for the manufacture of sand-lime products.

(To be continued).

With the exception of the Whitehall cement plant, which is being remodeled at Cementon, and the Northampton plant at Stockertown, which is in the hands of a trustee, all the cement mills of the Lehigh region are now in operation.

TABLE X.
Effect Of An Admixture Of Marble Dust.

Hydrated Lime	Sand	Marble passing 180 mesh sieve	Initial Compression of mixture in lbs.	Steam Pressure in lbs.	Time of Exposure to Steam in hours	Resistance to Compression after hardening in lbs. per square inch				Average
20	70	10	7,500	150	6	3.863	3.900	4.088	3.975	3.957
20	60	20	"	"	"	3.750	3.863	4.275	3.938	3.956
20	50	30	"	"	"	3.788	3.675	3.450	4.200	3.778
20	40	40	"	"	"	3.975	3.450	4.050	3.600	3.769

TUFA CONCRETE.

The Los Angeles Aqueduct is located in a sparsely populated region where transportation charges are unusually heavy. A local railroad has been built from Mojave to the intake, and freight charges on this line average $4\frac{1}{2}$ cents a ton a mile, or approximately 1 cent a barrel per mile. There is a stretch of 60 miles southwesterly from Mojave that diverges from all railroad transportation, at one point the conduit being 35 miles from the nearest railway. The transportation charges on the cement are a more important factor than its first cost.

The city of Los Angeles has constructed a municipal cement mill (described in the *Engineering Record*, Sept. 17, 1910) at Monolith, 15 miles north of Mojave, which is the approximate center of the aqueduct. This mill has now been operating for two years and has a capacity of 1,000 bbl. a day. It is making a Portland cement which complies with the standard specifications. While this cement mill has been successful in producing a product at a reasonable cost near the center of the work, it does not obviate either the high local freight charges north of Mojave, which amount to as much as \$1.25 a barrel, or the expensive wagon haul charge to points southwest of Mojave which, in addition to the local railroad freight, amounts to as much as \$1.50 a barrel.

Deposits of volcanic tufa were discovered along the aqueduct in the Owens Valley, 85 miles north of Mojave, in the Mojave desert about 20 miles west of the railroad, and at the site of the cement mill at Monolith. Tuff or tufa is a volcanic, fragmental rock which is made up of minute particles bearing the indications of having been laid down in water and partly consolidated. Sometimes tufa is a calcareous deposit, but that used for the manufacture of the cement described here is of volcanic origin. It is of a grayish or creamy color, and of a low specific gravity when in the rock form. When pulverized, the powder has a specific gravity of 2.2. It closely resembles and is probably the same as the German trass and the Italian pozzuolana, except that these last two are defined as of volcanic origin only, while tufa is described as being either volcanic or calcareous. The Roman hydraulic mortars consisted of a mixture of pulverized pozzuolana, slaked lime and sand. The tufa found along the line of the aqueduct occurs in large deposits and shows lines of stratification, indicating the probability of the ash having fallen on water and been laid down by process of sedimentation. In texture, tufa closely resembles the pumice of commerce. Its chemical analysis given in per cent is as follows: Silica, 68.96; alumina, 18.05; iron, 0.40; lime, 2.00; magnesia, 2.71; sulphur, 0.35; loss on ignition, 7.63; total, 100.10 per cent.

For a number of years past, the writer has been connected with the construction of hydraulic works in western desert regions where transportation charges often result in high cost of cement. This has led to experiments being made at different points on the possibility of making silica cements by blending ground quartzite rock with standard cement, and later, by grinding and blending volcanic products with standard cement. When investigations looking to the construction of the Los Angeles Aqueduct were undertaken, Mr. E. Duryee, formerly a cement chemist with the U. S. Reclamation Service, was engaged by the city for the purpose of conducting tests of material along the line of the aqueduct suitable for the manufacture of cement. The blending and grinding of tufa with cement was suggested by the writer. The development of the process described below was under the immedi-

ate direction of Mr. Duryee, assisted by Mr. G. M. Andrus, who at present is the chemist for the city in charge of the tests at all plants. Mr. Roderick MacKay is manager of the cement mill and tufa plant at Monolith, Mr. J. A. Roesch being in charge of Tufa Plant No. 1 at Fairmount, and Mr. O. J. Riggs in charge of Tufa Plant No. 2 at Haiwee.

The experiment was early made of grinding in the laboratory at the cement mill the tufa of the Mojave desert and blending it with hydrated lime. This resulted in a strong hydraulic mortar, subject to considerable checking when made in standard pats, but a mortar which becomes hard when set in water. This indicated that there was a chemical union between the ground tufa and the lime. The experiment was also made in the laboratory of grinding and blending tufa with standard Portland cement. The laboratory tests showed that briquettes made of the tufa and cement without sand were not as strong as briquettes made of straight Portland cement, but when the tufa cement was mixed with standard sand in proportion of 3:1, it developed as much strength in 28 days as the standard sand briquettes made with standard cement in the same ratio. Experiments were made with tufa from the three deposits in which the aqueduct engineers were interested. Practically the same results were obtained from each one. A mill run was then made of the tufa cement and this was put into the conduit work in the desert under conditions of extreme summer heat. The work stood up well, making a good showing under actual working conditions, both in the mill and in the field.

After completing these experiments, the first tufa cement plant was erected at Fairmount at a cost, for all charges, of \$22,000. This mill consists of an ordinary rock crusher with elevators, a ball mill and a tube or pebble-mill. This plant is operated by electric motors. The tufa is quarried, then run through the rock crusher and through the ball mill, where it is passed through a 25-in. mesh screen. At this point the raw tufa is blended with the straight Portland cement, and the blended product is then run through the tube mill, where it is ground so that 90 per cent will pass through a 200-mesh screen. The output of the mill, under ordinary working conditions, will average about 100 bbl. of the blended product per 8-hour shift. A great deal depends upon the dryness of the tufa when it is fed into the mill. If the tufa is but slightly moist, it runs through the fine screen much more slowly than if it is dry. In midsummer, when the tufa is thoroughly dry, the output of the mill may be increased 30 or 40 per cent, with the same operating crew. The tufa is not artificially dried, heated or burned in any way in the process of manufacture.

As the tufa is very light and easily crushed, the machinery for the first crushing and grinding of the tufa probably could have been made less elaborate and expensive than that which was installed. The limiting factor in the product is the fine grinding in the tube mill. It is possible to run the product through the ball mill in about 60 per cent of the time that it can be put through the tube mill. The mill that has been erected at Haiwee is practically a duplicate of the Fairmount mill and has the same capacity. The tufa will be handled in the same manner at the cement mill at Monolith as at the regular tufa mills.

The following is a cost statement for the month of July, 1910, per barrel of blended product, for operating the Fairmount tufa plant on a one-shift basis:

General expense—Labor, live stock, etc.....	\$0.04
Power, at 1.85 cts. per kw. hour.....	0.105
Quarrying	0.025
Mill operation	0.20
Net milling cost, per barrel.....	\$0.370

The characteristics of tufa cement, as compared with regular Portland cement in field work are that the tufa cement requires more water in the mix, hardens more slowly but continues the hardening process for a greater length of time. Tests made in the laboratory of the city engineer of Los Angeles showed that the Monolith tufa cement, with one part tufa cement to three parts of sand, gave a tensile strength in 28 days of 430 lb., in 90 days, 487 lb., and in 180 days, 573 lb. In this instance the blend consisted of 62½ per cent of tufa by volume and 37½ per cent of the Portland cement manufactured at Monolith.

The characteristic of absorbing more moisture and apparently holding it for a longer period of time than is the case with straight cement, makes it a better cement to use in hot, dry weather and not so good a cement to use in cold weather under freezing conditions.

Fig. 2 shows the results of some tests with tufa cement. The samples used in these tests were actual mill runs of 30 per cent by volume of tufa, 40 per cent, 62½ per cent, and 75 per cent respectively. There is also shown on this diagram tests made with straight Portland manufactured at Monolith. The blend show-

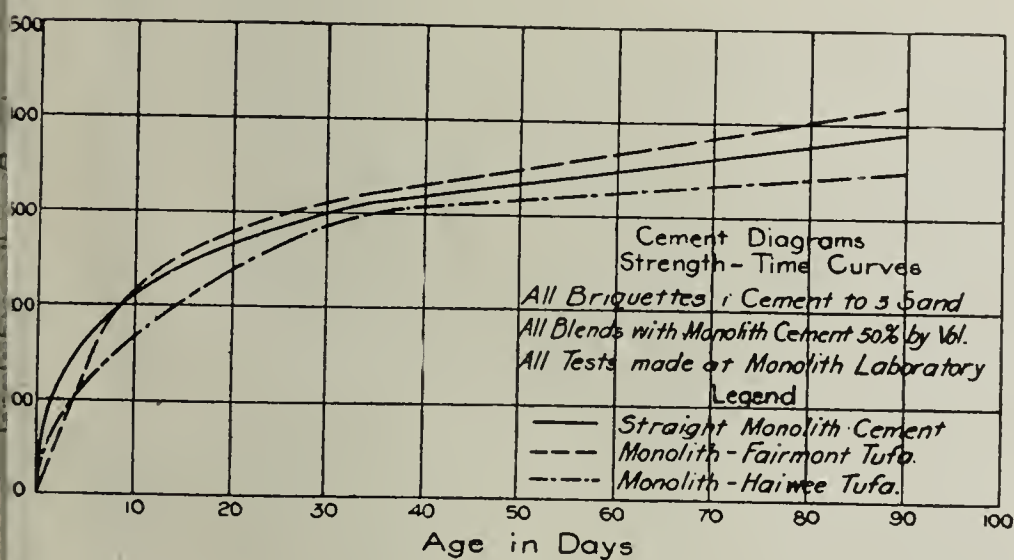


Fig. 1.

ing the best results is 62½ per cent by volume of tufa and 37½ per cent of straight cement. The results, however, are little different from those obtained with 30 per cent of tufa and 70 per cent of straight cement. The tufa has been ground with a standard Portland cement on the general market in the West and similar results obtained.

The blend that is being made at the Fairmount mill is 50 per cent by volume of tufa, and at the Haiwee mill the blend is 60 per cent by volume of tufa, the Haiwee tufa being somewhat lighter than the Fairmount. The tests given in Fig. 1 are the result of averaging a large number of samples. The extreme fineness of grinding and the natural plasticity of the tufa produces a dense concrete and one that finishes with remarkable smoothness. Tufa cement makes a smoother plaster than straight cement. A disadvantage, in some classes of work, consists in the fact that it attains its strength slowly, so that forms have to be left on the work somewhat longer. The roof forms on the Los Angeles Aqueduct, where the clear span is 12 ft., are stripped in six days when straight cement is used, and two or three more days are allowed when tufa cement is used.

A number of experiments have been made of the effect of adding a small percentage of hydrated lime to the tufa cement. The results obtained so far do not justify stating any definite conclusions resulting from such practice.

In addition to the laboratory tests made with the tufa cement, a number of field tests were made, the sands and gravels which were used being ordinary material found along the line of the aqueduct. Test slabs were made 6 ft. wide and 12 ft. 5½ in. long, 8 in. thick at the center and 6 in. thick at the ends, with a clear span of 11 ft. 5⅜ in. The reinforcement consisted of four ⅝-in. square twisted rods spaced 18 in. center to center, ½ in. from the bottom of the slab at the center, and bent up to the middle at the ends, and triangular mesh concrete reinforcement, 4-in. mesh with No. 12 longitudinal and No. 14 diagonal wires.

The tufa was made of one part, by volume, of tufa Portland cement, weighing 88 lb. per cubic foot and 2½ parts of washed sand containing 42 per cent voids and weighing 96 lb. per cubic foot loose, mixed dry and enough water added to make a plastic mortar. This was spread over five parts of crushed granite, the crusher run containing 40 per cent voids, and weighing 102 lb. per cubic foot, and the whole turned over three times by hand. The maximum size rock was 3 in., and a mixture of 1:2 of sand and rock contained 28 per cent voids with a shrinkage of 6 per cent

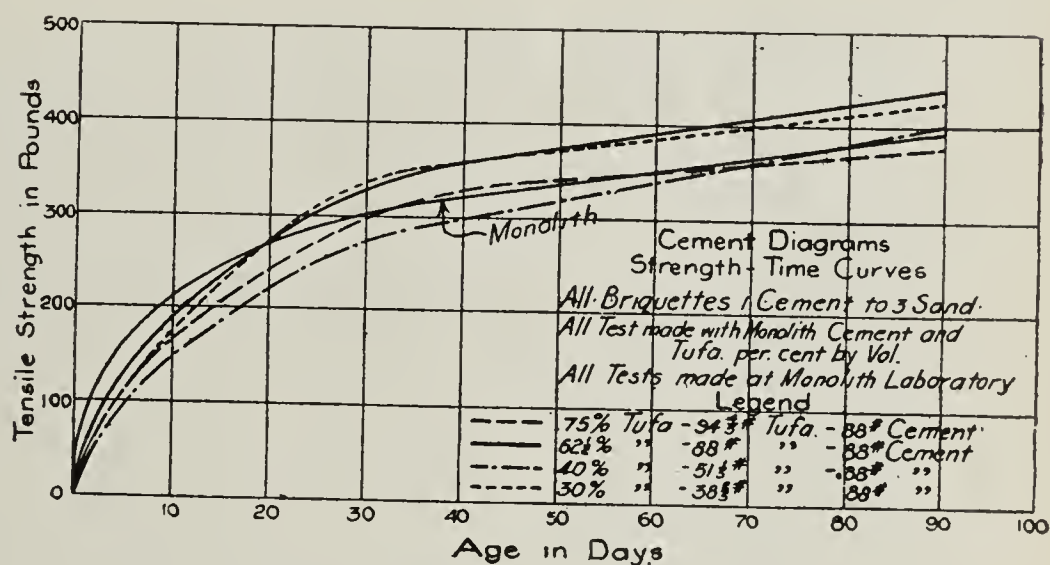


Fig. 2.

of the mass. Care was taken to place the concrete well and obtain equal conditions for all slabs.

Before the concrete commenced to dry out, it was covered with a layer of dirt and kept wet for 20 days, after which time the slabs were permitted to dry until they were tested. Two concrete piers 6 ft. long and 6 in. wide on top were built in a pit 2 ft. deep, so as to give a clear span of 11 ft. 5⅜ in. The slabs were then rolled over the piers and lowered onto a 1x4, resting on a ½-in. layer of fine sand. By this method, a uniform and flexible bearing was obtained.

A method of loading with water was used, thus eliminating arch action.

The slabs failed under the following loads: 32,225 lb., 21,000 lb., 25,000 lb., and 15,050 lb. The deflections at 1,000 to 2,000 lb. before failure, given in the same order, were as follows: 1⅝ in., 2⅝ in., 2⅝ in., and ¾ in. One slab carried 42,500 lb. with a deflection of 2⅞ in. without breaking, and, when the load was released, showed a set of 1¾ in.

One slab having a 6-in. uniform thickness and straight rods broke at 16,500 lb., and deflected 1⅝ in. before failure.

Mill runs have been made at the Monolith plant in

which tufa has been substituted for clay in the manufacture of Portland hydraulic cement, and a good product obtained. In this case, the tufa and lime were run through the kilns and burned as in ordinary process of cement manufacture. The clinker resulting was harder to grind than that obtained by using clay. Microscopic slides have been made of the tufa briquettes, but their examination does not throw much light upon the way in which the tufa combines with the cement. It is believed that the beneficial results obtained from using tufa with cement are both mechanical and chemical. The tufa will combine with any free lime in the cement, and the fine grinding not only improves the cement, but also permits the fine, silicious tufa to go one stage beyond the sand in making up the concrete aggregates.

In conclusion it may be stated that, both from laboratory tests and field experience, the tufa cement has proved as strong and as satisfactory generally as straight cement when used in making concrete. Its advantage on the Los Angeles Aqueduct is in the way of economy. The quarry and mill charge for taking one barrel of straight cement and blending it so as to make two barrels of tufa cement is about 74 cents; the price of straight cement at the points where the tufa plants are located is about \$2.50.

It must be remembered that these grinding plants are relatively small, operating on a one-shift basis, with an output of about 100 bbl. per shift, and that if operations were carried on a larger scale, the cost of grinding and blending this tufa would be much less. The writer sees no reason why there should not be marked economy in producing such a blended cement where tufa is available.

In the issue of the Engineering Record of Aug. 27, 1910, there is given a review of an elaborate investigation of "trass" cements, which was made under the direction of the Prussian Minister of Public Works. These tests show that the trass mortars consisting of 50 per cent trass and 50 per cent Portland cement, when mixed with sand and tested for tensile strength in standard briquettes, continue to harden after one year's time, the greatest strength being developed in the 5-year or oldest samples. They also show that the trass cement is slower in hardening, but ultimately attains a strength fully equal or superior to the straight cement and sand briquettes, when the volumes of trass cement and straight cement are equal. The higher the proportion of sand, the better is the relative showing made by the trass cements.

Unfortunately nothing is given in this review regarding the fineness of the grinding of the Prussian samples. In the work on the Los Angeles Aqueduct, this has been determined to be an important factor. In general, the conclusions of the Prussian investigators and of the Los Angeles Aqueduct engineers closely resemble each other, though they were entirely independent, as the report bearing on the Prussian tests only came to the knowledge of the Los Angeles engineers very recently.

As volcanic formations occur frequently in the western portions of this country, the use of tufa in the manufacture of cement may have general commercial importance on account of its economy.

SUBAQUEOUS CONCRETE WORK AT GODERICH.

Mr. J. H. Tromanhauser, engineer, Toronto, has just completed at Goderich, Ont., the construction of a 500,000 bushel annex to the elevator owned by the Gooderich Elevator and Transit Company. A brief description of this work, the early part of which was carried out by means of concrete pontoons, will be of special interest in this number.

The elevator annex is of monolithic concrete, designed in accordance with patents controlled by Mr. Tromanhauser, and consists of a series of 27 rectangular bins arranged in three rows on 18-foot centers. The side bins are flat bottomed and 80 feet deep, and the center bin 70 feet deep, having concrete hopper bottoms under which run two 30-inch collecting conveyors by which the grain is returned to the main building through two elevator legs and spout.

The main interest in this construction, however, is centered in the dock, or wharf, which was not built on the site—but some half mile distant. This work marks the first application in Canada of Mr. Tromanhauser's patent pontoon system of subaqueous construction.

The site on which the elevator annex is built was originally part of the harbor, with a depth of water of about 20 feet.

The pontoons for the concrete dock, of which there were four sections, were built on shore at a convenient spot across the harbor. They were each 54 feet by 14 feet, and about 4 feet high, all of timber and made watertight. After completion, they were launched and towed to the concrete mixing plant. Here the forms were set up and the concrete filled in together with the reinforcement, which proceeded as fast as the setting of the concrete would permit. The pontoons were so designed that the weight of the concrete walls would sink them about one foot for every two feet rise of the walls. This was found correct in practice. Ballasting was required as the work progressed. To prevent the concrete sections from becoming top heavy and rolling over, each section as it was completed was towed to the elevator site and sunk in position, the bottom of the harbor having been dredged previously and approximately leveled. The sections were sunk by admitting water into the compartments by means of hose. In large sizes, it is more convenient to build in sea valves for admitting the water.

Having sunk the sections, it was only necessary to drive the foundation piles through the timber bottoms and fill them up with gravel dredged from the site. The space between the shore and the concrete dock sections was then filled, and piles driven for the elevator foundation and the whole covered with the concrete slab to support the building.

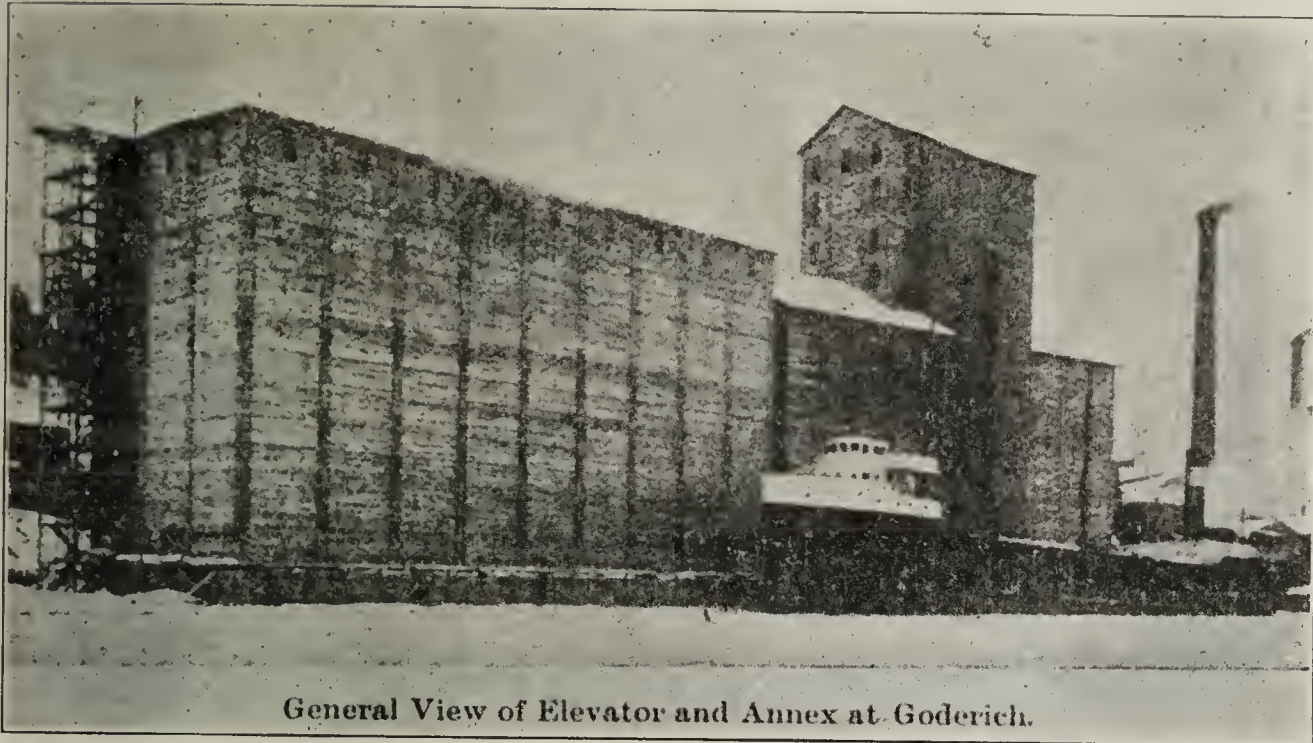
The advantage of this system over the old methods of coffer dam and concrete block construction will be appreciated by the engineer and contractor who have to consider similar propositions in regard to both fresh and salt water. It is particularly valuable in latitudes where timber is open to the attack of the teredo.

The sections being watertight, any material can be used for filling, there being no tendency for sand, cement, fine gravel, etc., to be washed out, but on the contrary, to become more solid and compact with age.

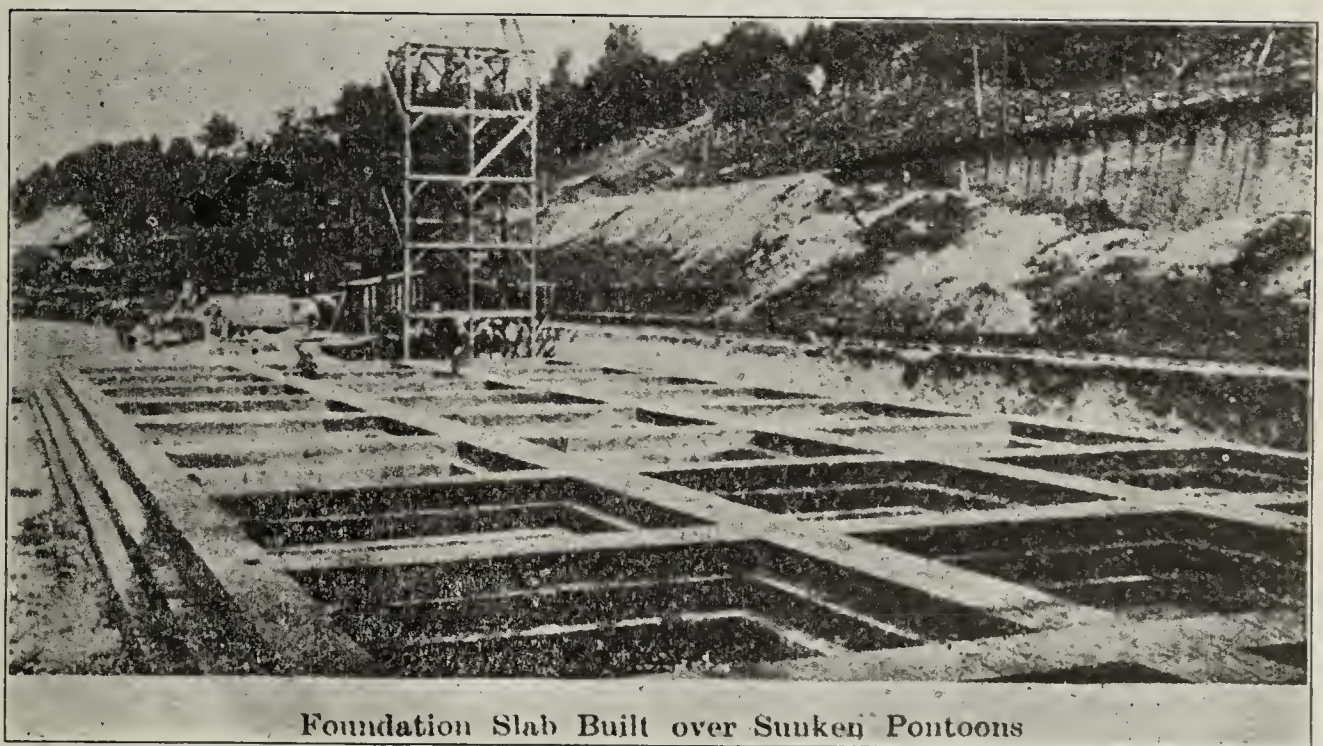
In conclusion, we may remark that this system has been found more expeditious and less expensive than the usual method, and is applicable not only to dock construction, but to a wide range of work, such as piers, breakwaters, lighthouses, foundations, sea walls and cofferdams.

Owing to the large number of orders on hand for the product of the Inland Portland Cement Company, they have decided to double the capacity of their plant at Metaline Falls, Wash., shortly after May 10th, according to F. C. Fiske, expert for the company.

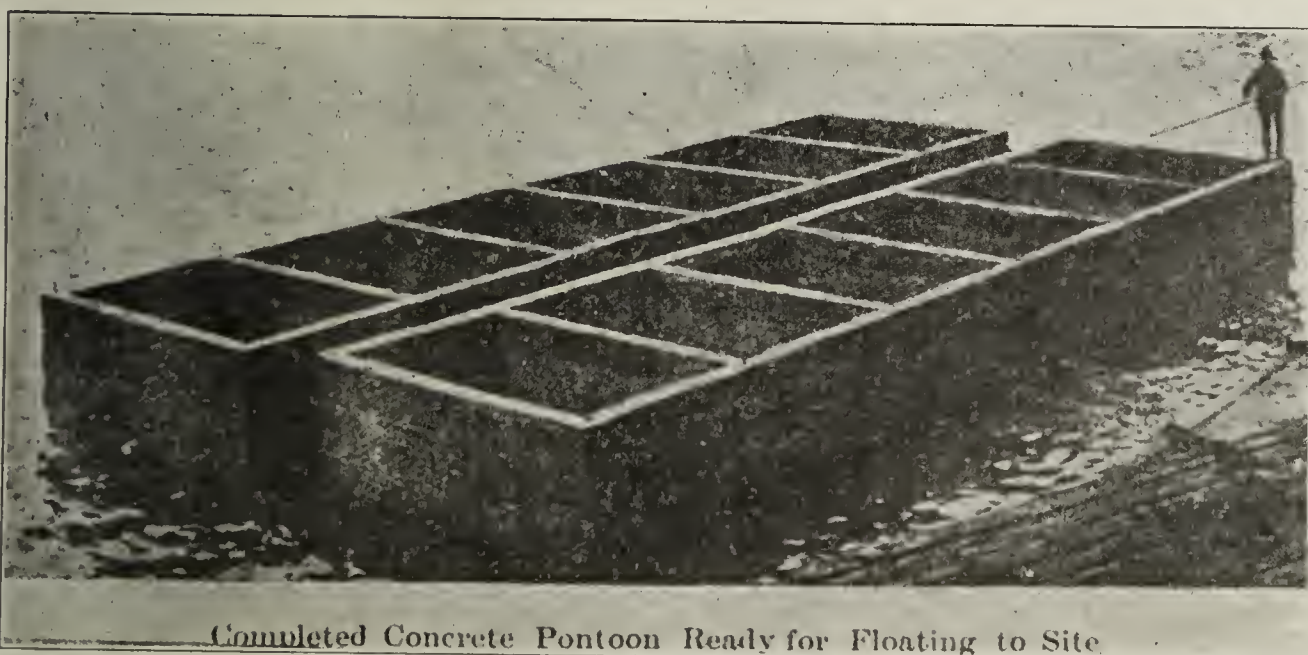
SUBAQUEOUS CONCRETE WORK.—CONSTRUCTION OF CON- CRETE GRAIN ELEVATOR IN CANADA.



General View of Elevator and Annex at Goderich.



Foundation Slab Built over Sunken Pontoons



Completed Concrete Pontoon Ready for Floating to Site

THE AMERICAN ASSOCIATION OF COMMERCE AND TRADE, BERLIN.

59-60 Friedrich-Strasse, Equitable Bldg.

Germany with its 65,000,000 inhabitants, highly cultured and becoming more and more exacting in their wants, no longer restricted to the necessities of life, is now one of the best fields for the sale of all the latest improved machinery and labor saving devices. The multitude of letters received daily by American consuls from American firms asking for assistance in the introduction of their goods is a further proof of the German market being a good one for the sale of American manufactures. For the purpose of aiding American manufacturers and business men in getting their goods into Germany and favorably placing the same, the American Association of Commerce and Trade was organized eight years ago by American business men doing business in the German Empire. The Association, carried on as an American Chamber of Commerce, with its Board of Directors and its committees is doing an unselfish work in aiding American manufacturers.

The Secretary, Mr. George S. Atwood, for the past twenty years in close touch with the German business

1900 less than eight million (8,000,000 barrels of cement were used, while in 1910 over eighty million barrels were produced—an increase of over 900 per cent in ten years. And if we go back to the year 1880 (when one hundred and fifty thousand barrels were produced) we get the startling increase of 53,200 per cent, or 533 barrels used in 1910 to 1 barrel used in 1880.

And the most wonderful thing is that during this tremendous expansion that the prices have gone down 50 per cent in ten years while the consumption went up 900 per cent. Not so with lumber, as statistics issued by the United States Forest Service show that between the years 1886 to 1898 the best grades of White Pine increased 113 per cent in price, and the rough 131 per cent, and while the prices of lumber increased, the quality decreased.

Now, the future of these two industries is readily seen. Concrete is coming to the front with great strides and the supply of lumber is gradually but surely decreasing. United States Government Officials state that within 50 years the entire supply of lumber will be exhausted and it is not difficult to foresee this. Just a few years ago vast areas of the United States



Textile and Fine Arts Bldg., State Fair Grounds, Dallas, Texas.
Exterior of Medusa White Portland.

Hubbell & Green, Architects. Dallas Cement Stone Works, Contractors.

world and the German government departments, is able to promptly answer all inquiries and save time in the establishment of American branches.

The work of the Association extends over the entire United States and all Germany. American business men, call upon the Association to help you and it will promptly and satisfactorily answer your call!

THE CONCRETE INDUSTRY.

Past, Present and Future.

There are but very few who realize the enormous extent to which the concrete industry has grown within the past few years; and the extent to which it will develop in the future is entirely beyond intelligent comprehension. Building materials have always played an important part in history and the different periods have been known as the Stone Age, Iron Age, and now we are in the midst of the Concrete Age. The history of its growth furnishes a reading more interesting than any fiction as it has accomplished things more wonderful than the author of the Arabian Knights ever dreamed of. No other industry has developed to such large proportions in so short a time.

Comparative figures for the past ten years show an enormous increase in the use of cement. In the year

were covered with virgin forest—today those same areas are entirely bare, the timber has been removed by the hardy woodsman, the farmer has come with his plow and today those same areas are fertile, prosperous, rich farming communities. County after county and state after state have been swept clean by the woodman's axe, until there is now but a mere handful of timber left in a few southern and western states. It is very evident that the lumber industry will very soon be a thing of the past.

The supply of Portland Cement is without limit. It is simply composed of clay, lime and sand, and anywhere where these substances can be found in fairly pure form, cement can be manufactured. Every State in the Union has cement formations and the beds are inexhaustible.

Concrete is the Only Thing that can take the Place of Lumber.

Gradually but surely it is forging ahead, reaching into every nook and corner of the civilized world. Everywhere from the smallest hamlet to the largest metropolis, concrete work of some kind can be seen in progress at practically any time of the building season. Everything is now being made of concrete, from the little 4x4 smoke house on the New England homestead to the thirty story sky-scraper in our largest cities,

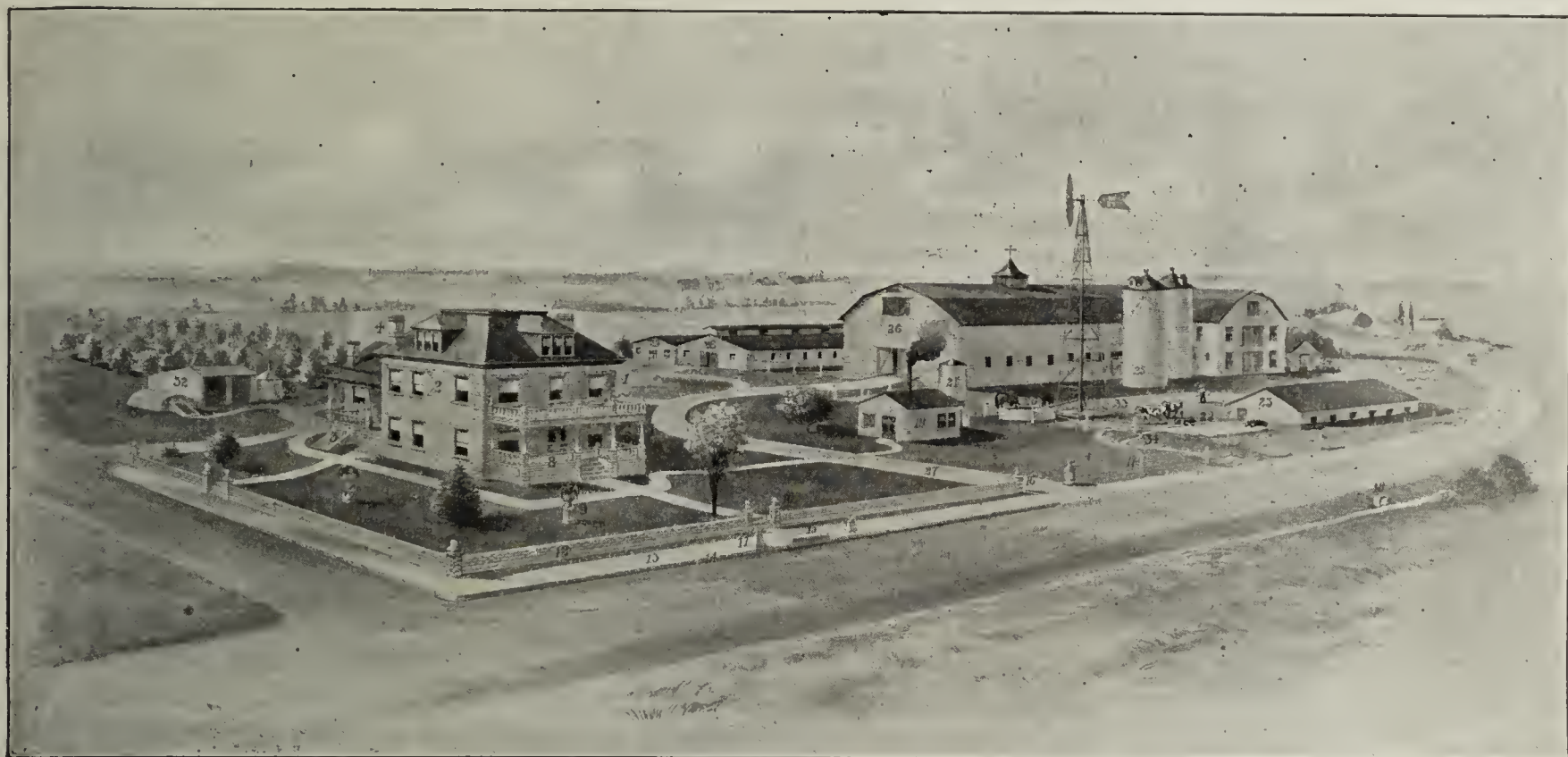
and from the 3-foot drain tile on the western prairie to the Panama Canal; everything is made of concrete and gradually but surely it is taking the place of lumber as a building material on the farms throughout the length and breadth of our land. It is a material so plastic and simple to mix that anyone of ordinary intelligence can successfully produce it. No expensive saw mills and extensive logging operations are necessary to make concrete. A few moulds, costing but very little, is all the machinery that is required and it can be made anywhere and at any time.

Concrete is not a new material; on the other hand it is one of the oldest building materials known: for instance, the Pantheon of Rome, built by Agrippa 27 years B. C., was made of concrete. It still stands without a flaw and in a splendid state of preservation—one of the oldest classical buildings in Rome. There are Aqueducts at Jerusalem still in existence, built long before the Christian Era. The Pyramids of Egypt were built of concrete, in fact instances without num-

hitching posts, fountains, lawn vases, flower boxes and jardinières, lawn seats and other similar articles; pergolas, balconies, lattices, sun dials and many other ornamental designs are now made of concrete. Not only in buildings and for decorative purposes is concrete used. Who would think of a concrete ship, yet there are several afloat on the seas. Concrete barges are now conveying boats on the Ohio river. Concrete rivals steel for armor plate material, and forms the basis of all modern fortifications. Concrete telegraph poles are no longer wondered at and concrete ties are being used very extensively. The Twentieth Century will surely go down in history as the Age of Concrete.

To Masons, Contractors, Carpenters and Builders.

You cannot afford to ignore the vast importance of this building material now recommended by the most up-to-date and influential architects in the land, writes the Northwestern Steel & Iron Works of Eau Claire, Wisconsin. You cannot afford to be without concrete



Model Farm Construction, Showing the Possibilities of Concrete Block and Brick Construction.

Courtesy of Northwestern Steel & Iron Works, Eau Claire, Wis.

1—Block Residence; 2—Window-Caps and Sills; 3—Cellar-Watering Tank; 21—Water Storage Tank; 22—Feeding Floor; Way; 4—Chimneys; 5—Porch Columns; 6—Porch Rails; 7—23—Hog House; 24—Corn Crib with Concrete Piers; 25—Porch Piers; 8—Porch Balusters; 9—Lawn Vase; 10—Corner Silos; 26—Block Barn; 27—Driveways; 28—Brick Horse Posts; 11—Hitching Posts; 12—Retaining Wall; 13—Side-Stables; 29—Brick Sheep Sheds; 30—Smoke House; 31—Root walks; 14—Curb; 15—Stepping Block; 16—Gate-Posts; 17—Cellar; 32—Garage; 33—Foundation for Windmill; 34—Fence-Posts; 18—Culvert; 19—Milk and Feed House; 20—Drainage Tile.

ber can be quoted showing the lasting qualities of this wonderful material.

In the present time there are innumerable canals, docks, dams, retaining walls, etc., in the course of construction throughout the land. Concrete bridges are no longer a novelty but a general thing. Practically no modern construction is undertaken without concrete in some form. A few years ago every sidewalk was made of wood; now, who would think of building a wood sidewalk. Concrete block and brick houses that a few years ago were looked upon with distrust are now becoming popular and in demand. Concrete is also rapidly taking the place of lumber on the farm and the American farmer is now the largest user of cement. Why wouldn't it be reasonable to believe that within just a few years almost everything on the farm will be made of concrete?

Concrete Makes Model Farms.

Residences, barns, stables, chicken houses, cisterns, cellars, drain tile, sewer tile, feeding floors, flower urns,

machinery—a mixer for your foundation, sidewalk and other work; a block machine for moulding your own material; a brick machine for chimneys and fireplaces; porch column and baluster outfits for porches and balconies; a sill and cap mould for steps, caps, lintels, etc.; in fact anything that may be required in the building line and for making articles which you can sell in connection with your regular business. It will surprise you to learn how inexpensive such an outfit would be, and it will add wonderfully to your income.

Send for a Copy of our 1911 Concrete Machinery Catalog.

Our 1911 catalog contains the largest and most up-to-date line of concrete machines, moulds, parts, tools, etc., ever shown in any catalog. Send for a copy.

We make everything in the concrete machinery line from the cheapest moulds to the highest priced Automatic Machines, and we figure our prices at so much per pound. Our foundry capacity is over 15 tons per day, and our manufacturing capacity is over 100,000 square feet of floor surface.

"Ceresit" Invades America.

German Waterproofing Compound in Paste Form, placed on United States Market.

By S. J. Samelow

Engineers, contractors and builders generally are very much interested in the waterproofing paste for concrete construction sold under the name of "Ceresit." It is a German product, or rather a product of German origin, which was introduced into this country about two years ago. In that brief space of time it seems to have attracted the attention of the most serious on the question of waterproofing.

There are several compounds on the market that bring about desired results. The Ceresit Waterproofing Co. claims features for its waterproofing that have been sought for years. Whatever there may be to these claims, this much may be stated impartially, that "Ceresit" at least widens the scope of waterproofing to the extent of another excellent formula for the American builder. Simple tests will no doubt determine the comparative efficiency of this compound. Builders who have used it recommend it highly.



P. H. HANSEN,
Manager, Ceresit Waterproofing Co.

"Ceresit" is not a powder, but a paste. It is of a creamy consistency like butter. It is cream white in color. Its specific gravity is about the same as that of water. Mixers measure it by weight or volume. It is easily soluble in water. Where intermolecular waterproofing of the entire mass is desired, the solution of "Ceresit" and water is used in the concrete instead of plain water. It is similarly used for mortar coatings. Whether used for cement mortar or for waterproofing of concrete, the solution containing this compound distributes itself uniformly through the material. This is a virtue that builders consider highly valuable. For it is always desirable to make the resistance to water uniform throughout, as the effectiveness of a water-proofed surface may be measured by the weakest part of it.

"Ceresit" comes from Germany. It was invented by Dr. Paul Mecke, a chemist, who has been experimenting with waterproofing compounds for more than twenty years. It has been used in Germany on government and public work as well as in structures of big commercial projects, and reports on these indicate that the product is worth all the manufacturers claim for it.

Among the important European structures waterproofed by "Ceresit" are a tunnel in Bremen, Germany; a swimming pool of artistic design in Seitz, Germany; the castle of the Emperor of Germany built

at Posen in 1908. One of the severest practical tests on the compound was made in a water pavilion exhibited at the World's Exposition in Brussels, in 1910. This pavilion was built in a lagoon. Its base was five feet below the water level. The walls were of concrete four and a half inches thick. The waterproofing was accomplished by a cement mortar coating three quarters of an inch thick, which was applied to the outside of the concrete walls. Over this structure, a giant fountain poured a continuous stream of water at the rate of 15,000 gallons an hour. Yet despite of this powerful stream washing the walls the visitors' reception room inside of the pavilion remained free from all moisture or dampness.

Even Egypt, the seat of much hidden knowledge on



Ramholz Tunnel in Germany, Waterproofed with Ceresit.

concrete, is using "Ceresit." The Ceresit Waterproofing Company is displaying a photograph in its offices of a church that was waterproofed with "Ceresit" in the lands of the pyramids.

The main office of the Ceresit Waterproofing Co. is at the Commercial Bank Building, Chicago. The factory where the product for American consumption is made is located at 718 South Canal street of this city. Dr. Paul Mecke, the inventor, supervises the Canal street laboratory, and the compound is made under his personal directions. The American corporation is composed of the following officers: T. F. Koch, Houston, Tex., president; P. H. Hansen, Chicago, general manager and secretary; Dr. Paul Mecke, vice-president and chemist.

"Ceresit" is used both as a waterproofing compound

for concrete as well as for cement mortar. One of the effects sought in concrete construction is a toning up of the finished product. A darkened effect in concrete is undesirable. Architects prefer the brighter or lighter shades in the concrete, which gives it a more cheerful appearance and a closer approach to the best grades of stone. "Ceresit," engineers declare, has the virtue of slightly bleaching the natural shade of concrete, which results in most pleasing effects. Another commendable feature of "Ceresit" is that it is free from offensive odors. It is as odorless as water.

A great advantage of the use of "Ceresit" is that it can be distributed uniformly throughout the concrete or cement mortar. There is no danger, therefore, of having an excess of the compound in one portion of the building material and a deficiency in another. The most unskilled laborer can achieve the greatest uniformity desired.

The manufacturers guarantee that the compound is sufficiently elastic to expand or contract under varying conditions of temperature. This prevents disastrous results where frost acts on the structure. They also guarantee that "Ceresit" does not reduce the strength of the cement but rather increases it. The compound is recommended for any material, brick, stone, concrete or tile.

The first job in the United States where "Ceresit" was used was the Harper Memorial library at the University of Chicago, of which Shepley, Rutan and Coolidge are the architects. In order to secure this contract the manufacturers gave a surety bond for \$5,000 to guarantee the basements of this building free from dampness for a period of three years. Many big structures have been waterproofed by the company since then. Among these are the swimming pools for Y. M. C. A. buildings at Wilson avenue, Hyde Park, Chicago, and Gary, Ind.; also one for Doubleday Page Company, at Garden City, L. I., N. Y.; basements of the Harold McCormick residence at Lake Forest, Ill.; the Tuberculosis Hospital at Oak Forest, Ill.; the library building at the University of Toronto, Ontario; the Black Hawk National Bank Building, Waterloo, Ia.; the Philadelphia Safe Deposit Company building; the Dominion Bank building, Winnipeg, Manitoba; the City Hall of Ottawa, Ontario; the Hermitage Hotel of Nashville, Tenn.; and the concrete reservoir for the Navy Station at Key West, Fla., which holds 1,300,000 gallons of water.

The company has branch offices in all important cities of the country.

A NEW FORM OF ASPHALT PAVEMENT. Which is Superior, in Every Respect, to Any Other Pavement now before the Public—Noiseless, Economical and Unsurpassed for Durability and the Satisfaction Afforded.

There is now in course of construction on the roadway of Thomas street, between Broadway and Mercer street, New York City, a new form of asphalt pavement, which is in every respect far superior to any other form of pavement hitherto in use, whether Macadam, Belgian Block, Trinidad Asphalt or Wood Block. This pavement consists of what is known as compressed rock asphalt slabs, laid upon a concrete base, finished on top with a thin "rubber" coating of pure rock asphalt. These slabs are composed of natural rock asphalt obtained from the mines of the Neuchatel Asphalte Co., Ltd., at Travers, in the Canton of Neuchatel, Switzerland, admittedly, the highest grade rock

asphalt in the market. The rock, after being mined is ground to powder, which, after having been properly heated, as in the case of ordinary compressed asphalt, is compressed in special moulds under a hydraulic pressure of 3,000 pounds, to the square inch. These slabs when laid, are about 10 inches square and $1\frac{3}{4}$ inches in thickness, and are laid upon a concrete base 4 to 5 inches in thickness, with a cushion of cement and sand mixed dry, of just sufficient thickness (about $\frac{1}{4}$ of an inch) to level up any inequalities of the concrete base, so as to afford a firm and level bed for the slabs. The slabs are laid with the joints as close as possible, in exactly the same manner as tile on a tile floor. When all the slabs are laid and levelled, the entire surface is sprinkled with water from a sprinkling can, so that sufficient moisture may penetrate through the joints to enable the cement underneath to set up. After this, the entire surface of the slabs is covered with a thin coating, not more than one quarter of an inch in thickness, of pure rock asphalt, heated in kettles and spread over the surface with a wooden float in the same manner as an ordinary rock asphalt sidewalk or floor, and dusted over with a light coating of dry cement, lightly brushed in with a broom. This forms what is called the "rubber" coating, so called, from the "rubbery" nature of the wearing surface thereby obtained, which being composed of pure rock asphalt, the same material as the slabs, forms a comparatively soft yet tough covering, which, while it marks up easily, does not break or wear into holes. On account of this rubbery character, the surface affords an absolutely sure foot-hold for horses, as their shoes indent the surface sufficiently to prevent any slipping whatever, while turning or backing in cold weather, or when the surface is wet or covered with snow. This is an invaluable quality for a roadway in such a district where this present pavement is being laid, which being in the heart of the wholesale dry goods district of the city, is subjected to exceptionally severe usage. It is also a form of paving, that has been devised to meet the requirements for the driveways and loading platforms, etc., of dry goods establishments, department stores, railroad and express yards or any other places where there is exceptionally heavy traffic, and where considerable backing and turning of trucks is required. This pavement is laid by the Neuchatel Asphalte Co., Ltd., of 265 Broadway, the American Office of the Neuchatel Asphalte Co., Ltd., of London, England, and Travers, Switzerland, the sole owners of the mines from which the rock asphalt is obtained. This company lays this form of pavement under a ten year guarantee, which it can safely do as the cost of repairs are very slight.

In process of time, if the line of traffic is all in one place, the rubber coating becomes pushed out as it were, on either side, and wears gradually thinner and thinner, until the surface of the paves themselves is reached. In this case, all that is necessary, is to replace this thin rubber coating in the worn spots, the paves themselves underneath being absolutely uninjured, and becoming under the traffic gradually, so compressed one into the other, that all joints are closed, and the whole surface become absolutely continuous. Such pavements have been laid by this company at the following places.

Warehouse for the Central R. R., Newark, N. J., in 1907; Trimble place, New York City, N. Y., in 1907; McCreery Bros., New York City, N. Y., 1910; No. 47-51 E. 52nd street, New York City, 1910; and the repairs to same since they have been laid, have been merely nominal, and the pavements themselves, are in just as good a condition now, as the day they were laid.

FACTORY BUILDINGS—MINNESOTA STATE PENITENTIARY.

At the Minnesota State Penitentiary at Stillwater there are being built several factory buildings that are interesting both in design and in method of construction. The interior view shows an unusual form construction. In place of lumber sheeting for the ceiling forms, there was used corrugated sheet steel. This

periments, which have had to do with wet mixtures. Two lines of hose, one carrying the dry-mixed cement and sand and the other water converge in a brass nozzle, where the cement, sand and water come in contact, the flow of water being governed by a faucet attached to the hose. The gun shoots the contents with great force, the nozzle being held about 2½ feet from the surface to be covered with cement or stucco. The

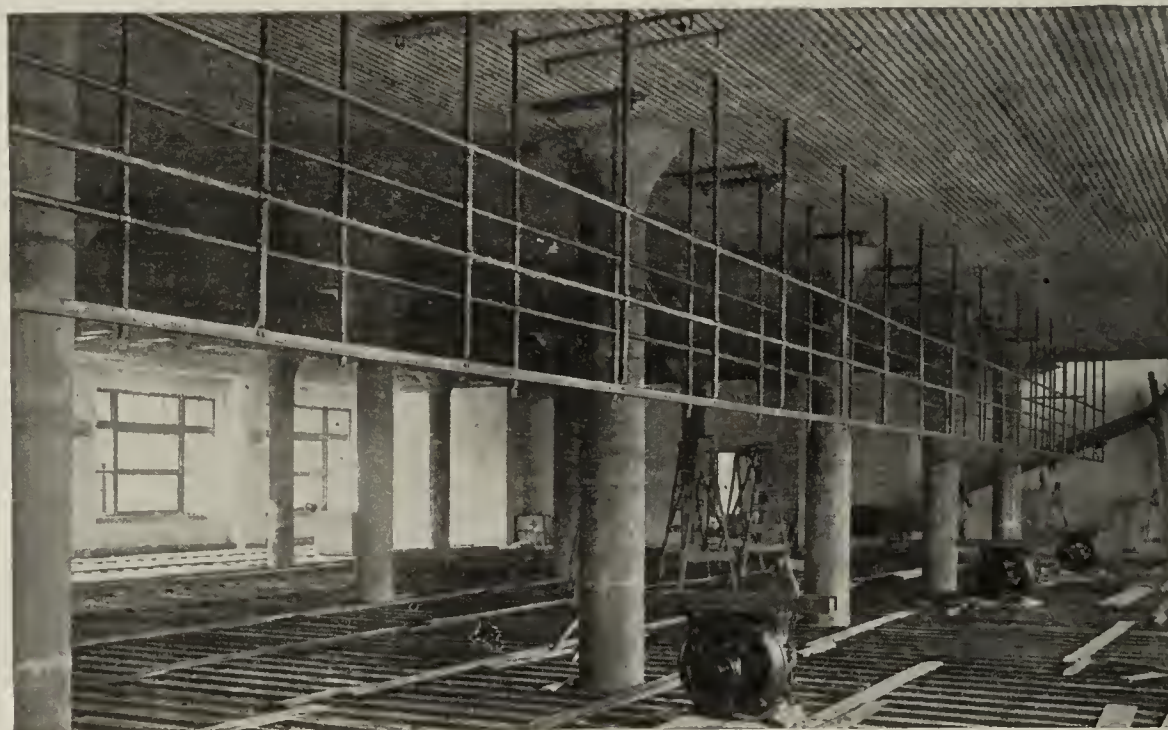


No. 1. Concrete Factory Buildings for Minnesota State Penitentiary.

may be used many times, and where several floors are to be built, it effects quite a saving.

The motors are about to be raised to the ceiling for inverted suspension. The pipe framework will support a walk the full length of the room. The other pictures show various stages of the work and the end wall of a previously completed reinforced concrete building.

machine acts with such force and precision as to make a perfectly mixed and dense waterproof concrete or mortar, apparently impossible to achieve except where great air pressure is used. It is entirely automatic and its precision is in marked contrast with hand work where the personal equation is such an important factor. A surface with interstices will be entirely



No. 2. Interior View.

THE CEMENT GUN.

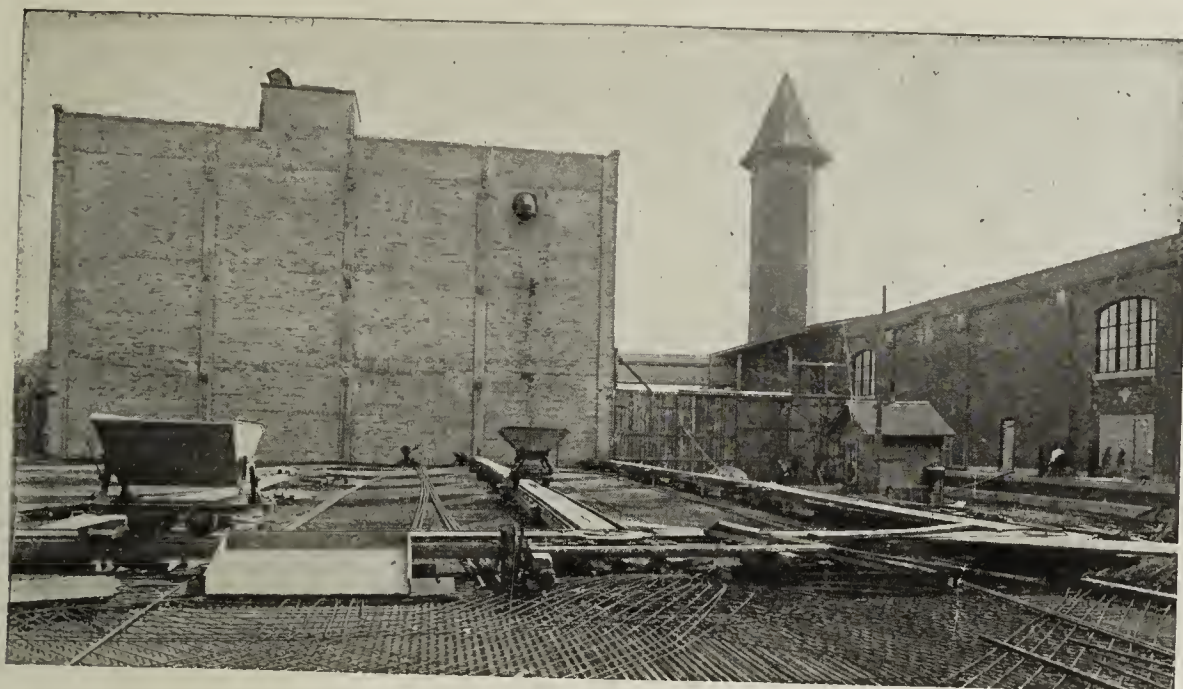
Perhaps no exhibit shown at the Cement Shows in New York, Chicago and Toronto awakened greater interest on the part of engineers, architects and contractors than that ingenious piece of concrete machinery known as the "cement gun." Briefly stated this machine consists of an engine and compressed air tanks with tank for the dry material, cement and sand. The fact that the aggregates are mixed dry is the chief distinction between this process and former ex-

filled instead of being bridged over as is frequently the case with trowel work. The machine will cover a square yard of surface with concrete 1 inch thick in about two minutes. The concrete will be of maximum density. In the construction of massive concrete, the stone could be first placed and mortar or binding material applied by the machine. How satisfactory and economical it might be in work of this character was not so apparent, in a recent demonstration, as its wonderful utility in ordinary construction, such, for example, as stucco work, small buildings or fences re-

quiring but an inch or two of dense and impervious cement mortar. To illustrate its utility in this field, an ordinary roll of chicken wire was bent into the form of a post and upon the inside was placed ordinary sheathing paper. The hose was played over this form and there quickly resulted a strong and perfectly satisfactory hollow waterproof concrete post, 8 or 10 inches in diameter and with a uniform thickness of perhaps 2 inches. The same process of construction was applied to small structures, making what might be termed indestructible tents or buildings of thin concrete. One of these buildings, a most flimsy affair in the way of preliminary studding, wire and paper, was filled with shavings and boards, and afterwards set on fire, the mass burning to ashes but without heating the thin walls upon the exterior surface. The machine will undoubtedly bring about a veritable revolution in the construction of very small buildings, fences, posts, stucco work and kindred operations, as it eliminates the use of forms and scaffolding, only ladders being required where it is impossible to use the machine with the workman on the ground. As stated, the water is added

slab poured in place, uniting the entire framework of individual members into a unit structure.

Stone, sand and cement were hauled on an industrial track to a hopper, whence a second track at right angles led to the overhead bins of the mixer plant. This second track was laid up a sharp incline built on trestle work and from this point the material progressed by gravity entirely until it was ready for delivery to the casting yard. The latter was situated along the front of the building between it and the supply track. The cars loaded with concrete from the mixing plant traversed a track which ran close to the building front and parallel with it. The casting forms were arranged alongside this track so that it was exceedingly simple to pour the various members. An ingenious arrangement was used to return the emptied cars to the mixer plant. The track from the mixer to the yard was on an incline. A double drum with a counterweight was rigged up and the cars attached by means of a rope running over the lower drum. The ratio between the upper and lower drums was one to eight and the weight was so regulated that when the car was loaded



No. 3. Constructing reinforced concrete floors for the new Factory building at Stillwater for the Minnesota State Penitentiary. Orenstein-Arthur Koppel Cars used in hauling the concrete.

in the nozzle, the surface first receiving a thin coat of cement grout followed in turn by additional cement and sand until the required thickness of surface is obtained. By holding the nozzle stationary a 5-inch cone will soon protrude from the surface.

CONSTRUCTION PLANT FOR A UNIT CONCRETE BUILDING.

A recent development in reinforced concrete design put forward primarily to overcome the objection to monolithic concrete construction of its "terrible permanence," is the unit type consisting of a structural concrete framework with poured slabs. Naturally this new development has brought with it its own problems, not only of design but of mixer plant arrangement, and a notable example of this kind of concrete work at the new plant of the United Shoe Machinery Co. at Beverly, Mass., is interesting from a construction standpoint.

Mr. E. L. Ransome, who has been called the pioneer of reinforced concrete, was retained as consulting engineer on the erection of the new buildings and he was responsible for all the features of the concreting. Columns, girders and beams were moulded as units in a section known as the casting area. When thoroughly set these were swung by derricks into place and a light

with full buckets it would go down the incline at a reasonable speed, starting and stopping, being regulated by means of a brake on the hoist and pull of the weighted drum. The empty cars were returned up the incline by the usual type of hoisting engine and wound up the weighted drum at the same time. This device worked very well.

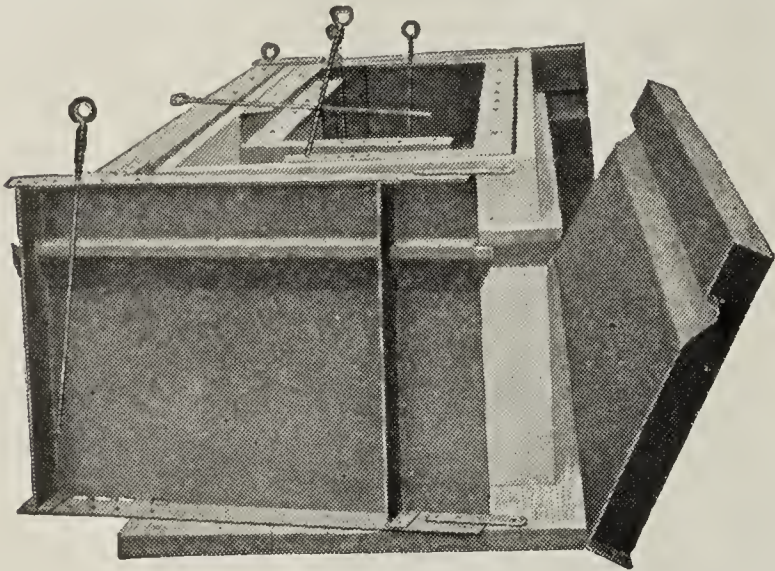
For handling the cast sections two trucks were used, one was an inclined A-frame traveling crane running on a track parallel with the building front with a horizontal radius of 50 ft. This served to pick up the finished girders and beams, which were cast in the gang mould, and delivering them to the section of the building where they were wanted. A beam truck with 50 ft. radius, located inside the building, then delivered the finished sections to the more remote parts of the building if required. With this plant the work was carried forward at unusually good speed. A floor was set on an average in nine or ten working days, a bay 20 ft. by 60 ft. across the building being run in a day. There was practically no breakage.

The cost worked out to be approximately ten per cent lower than usual practice in monolithic concrete construction, a significant indication of what may be expected with greater experience in this new type of concrete construction.

AUTOMATICALLY SEALING BURIAL VAULT.

A great amount of enthusiasm has been created among undertakers and people in general by the invention of an absolutely waterproof, two-piece concrete burial vault which seals automatically. Besides being perfectly waterproof, it is not excessively heavy, is a model of neatness and design, and undertakers everywhere immediately recognize its superiority because it fills every requirement.

Wooden vaults soon decay; stone or brick vaults cannot be made waterproof, and in most cases serve only the purpose of supporting the earth; steel vaults are soon destroyed by rust; concrete vaults which necessitate the use of cement to seal the joint between the lid and the body of the vault can hardly be made absolutely waterproof because of the impracticability of uniting pieces of dry concrete under the usual conditions at a cemetery. Yet, even with this uncertainty, it has been recognized that concrete is the most durable and at the same time the most practical material from which to construct burial vaults.



Removing adjustable mold from completed vault in 12 hours. Note the clean-cut outline.

The sectional view of this perfected burial vault (shown on page 198) shows how the lid extends down over the sides, thus prohibiting any possibility of water entering at the joint on account of the pressure of the air contained in the vault. This is a well-known scientific fact, and can be easily demonstrated by inverting a larger tumbler over a smaller, and, keeping the bottom of the smaller tumbler turned downward. Immerse in water. It will be seen by this simple test that water will not enter either tumbler.

The illustration also shows a small amount of cement placed on the ledge of the vault. It is not the purpose of this cement to make the vault waterproof, but sanitary, by hermetically sealing it so as to retain poisonous gases or effluvia laden with germs of contagious disease.

This invention was perfected and patented by the Automatic Sealing Vault Co., of Peru, Indiana, and should be thoroughly investigated by every vault manufacturer or any one expecting to enter the concrete vault business. Large illustrated catalogue sent free on request.

REPAIRING CONCRETE FLOORS.

There is a popular and widespread fallacy to the effect that a concrete floor once chipped or cracked is practically at the end of its usefulness. This is undoubtedly due to the results of unskilled workmen attempting to repair a damaged floor. Unless proper care is taken and the workman engaged on the job has sufficient knowledge of concrete, a repair job is most unsatisfactory.

In this connection, the practice of the Aberthaw Construction Co., Boston concrete contractors, is worth noting. In certain of the concrete buildings erected by this firm, floors have been chipped in particular places because of dropping heavy materials in one place, as, for example, the winding rolls in a paper mill. When a floor has become chipped out in some such manner as this, the proper method of repairing is to chip out with mallet and chisel a recess usually square, of sufficient depth to reach to the bottom of the deepest crack in the concrete surface. The rough surface resulting from this process is then treated with acid to bring out the solid aggregate, or else a stiff brush is used to remove all the loose dust, and the recess washed out by sluicing out with a hose. When all the dust particles have been removed the recess is grouted with cement and before this has set the granolithic finish applied and leveled up with the rest of the floor.

Repairs made in this manner are just as permanent as the remainder of the floor, as the bond between the new and old concrete will be perfect if all the loose material has been carefully removed.

CLAY PRODUCTS SHOW.

The report has been current that the clay interests are to hold a Clay Products Show in the Coliseum in Chicago next winter in January or February. This report seems to have some basis of fact.

At the January Convention of the Illinois Clay Manufacturers' Association, held in Chicago, a committee was appointed to take in charge the promotion of a Clay Products Show. A committee of four was appointed to which there was later added a representative of the National Brick Manufacturers' Association. A speaker at the last convention of the National Brick Manufacturers Association is quoted in "The Clay Worker" as follows:

"There is no question but what the Clay Products Show will be given in Chicago. It will undoubtedly be given in the Coliseum or the Armory and a creditable exposition will be presented. I do not think the members of the clay industries realize what a magnificent exhibition can be given in connection with the industry of clay working and it remains for this Association, the State Associations, the National Paving Brick Manufacturers Association and all the allied associations in the clay industry to unite in giving one grand exhibition. The question of an exhibition of clay products is not a formidable one when you consider for a moment that common brick, faced brick, fireproofing brick, paving brick, ornamental terra cotta, wall and floor tile, roofing tile and all burned clay manufacturers can show model demonstrations of fireproof buildings. It is possible for us to give an exhibition in Chicago which will far excel in architectural beauty the shows given by the cement people."

Those connected with the cement industry, particularly the exhibitors at the annual Cement Shows, will doubtless watch with keen interest the Clay Products Show to be held by the clay interests to check the impetus given concrete construction by the series of successful cement shows.

CONCRETE OF MAXIMUM DENSITY FOR A STANDPIPE.

It was determined at the very start of the building of the Westerly, R. I., water-tower, illustrated in this

journal on Sept. 24, 1910, that dependence should be placed on a very dense mix of concrete to insure watertightness, and in order to attain this result a large number of tests were made to discover the proper mixture for obtaining the maximum density with the aggregate at the disposal of the builders, and then to insure every batch of cement being as nearly as possible of the predetermined density. These methods were recently described at a meeting of the Boston Society of Civil Engineers by Mr. A. B. McMillan, engineer of the Aberthaw Construction Co., the builders.

The first step was to make mechanical tests of the sand and stone available. Two sizes of sand were tried, one a bank sand of the size commonly known as paving gravel and called No. 4½, and the other a fine bank sand known as No. 5. Crushed gray Westerly granite of all sizes between ½-in. and 1½-in., as screened at the crusher, was the stone used on this work. For testing purposes 100 ounces of material were used at a time. Samples were selected from the pile by quartering in order to get as nearly as possible average results. As the screens were not calibrated, values from Taylor and Thompson's "Concrete, Plain and Reinforced," page 194, were used. The first sample of stone, known as No. 4½, gave the following results, the amounts given being in all cases the per-

these results obtained with No. 3, the one used, are given: 1½-in., 7¼ per cent; 1-in., 35½ per cent; ¾-in., 48 per cent; ½-in., 67 per cent; ⅜-in., 79 per cent; ¼-in., 93½ per cent; 3-16-in., 96½ per cent; ⅛-in., 98 per cent; No. 20 screen, 98½ per cent; No. 30 screen, 99 per cent; No. 50 screen, 100 per cent.

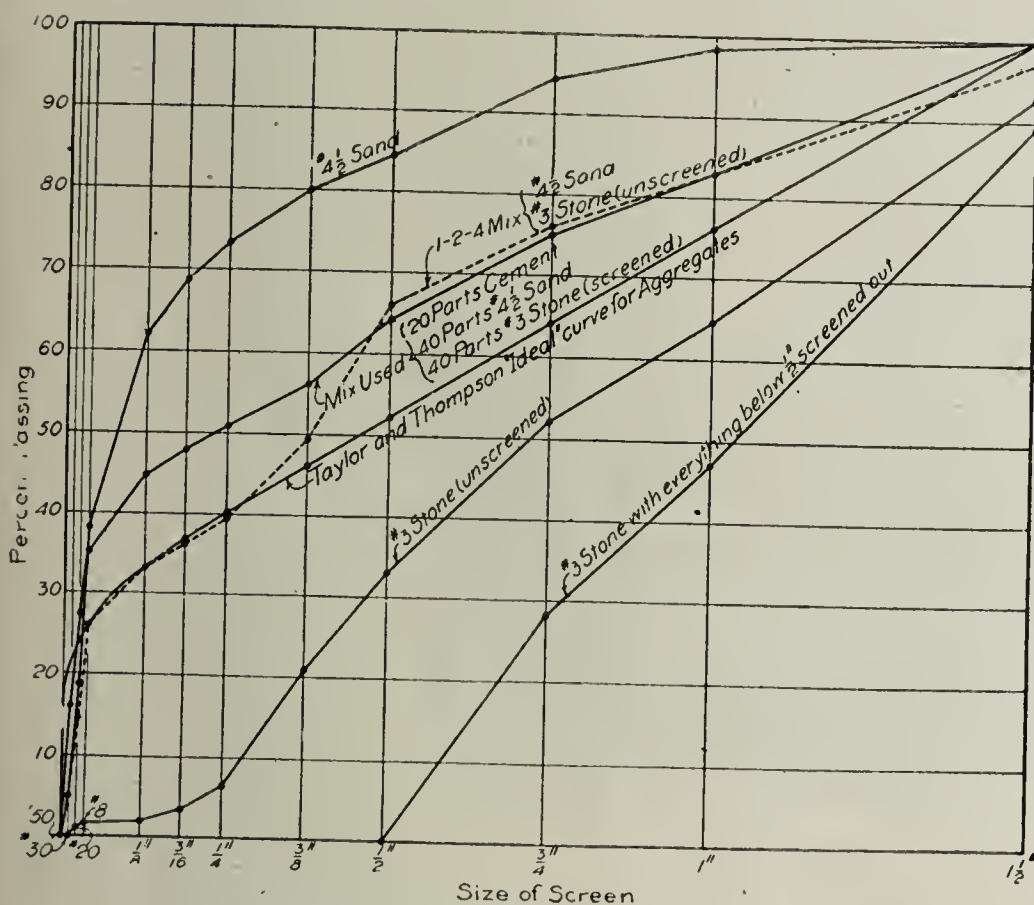
This stone, No. 3, was used with the coarse sand, No. 4½, and Vulcanite Portland cement in the proportion of one part cement, two parts sand and four parts stone, and tested. The curve obtained by this combination is shown by the dotted line on the accompanying diagram. It was obvious that No. 3 stone and No. 4½ sand as they stood could not be combined into a good curve. It did seem possible, however, to modify this by screening, and after careful consideration it was decided to remove from the stone everything that would pass a half-inch screen. This screening was done by hand on a small screen. A second trial was then made using a mixture of 16.9 parts Portland Cement and 28.7 parts sand and 53.5 parts of stone by weight. This mixture gave a curve that was practically coincident with the "Ideal" curve recommended by Taylor and Thompson. Trials for density were then conducted.

For this purpose a cylindrical can made of riveted 7-16-in. steel plate was used. This can was 10 in. in diameter and 15 in. in depth. Fifty pounds of material was mixed in a metal box by hand and enough water was then added to make a mix that would barely quake when mixed. The concrete thus formed was then transferred to the cylindrical can and the distance down from the top of the can to the top of the mixture was carefully measured. The densest mix obtained was found to measure 7 in. down from the top of the can, thus giving a total volume for the 50 lb. of concrete of 610 cu. in. It was also determined that a variation of ⅛ in. in height of mixture in the can above the mark set by this densest concrete corresponded to a change in volume of 1.6 per cent, thus giving a handy means of comparing any trial mixture. The density tests showed that the mixture giving a curve most nearly approximate to the Taylor and Thompson "Ideal" gave an excess volume over the best mixture of 6.4 per cent and it seemed also to be lacking in mortar.

It was then decided that the concrete should be mixed so rich as to make only 12 cu. ft. to four-bag batch. The latter result was finally obtained with a mixture of 20 parts by weight of cement, 40 parts of No. 4½ sand and 40 parts of No. 3 stone screened to remove everything below ½-in. This mixture had the maximum density of any that was measured and appeared to be satisfactory in other respects. The curve given by this mixture, however, on volumetric tests, was nearly 10 per cent higher than the "Ideal" of Taylor and Thompson at the point of tangency. In an endeavor to get even greater accuracy, a can of smaller diameter than the first was made and further tests conducted with this. Twenty-eight various mixtures were tried, using this small diameter can, but the mixture mentioned above still showed the best results of any tested and it was accordingly decided to use this on the work.

Further tests were conducted for the purpose of ascertaining whether or not even greater density might be obtained by the addition of hydrated lime to the mixture. It was found that with the densest mix the addition of hydrated lime increased the volume almost directly in proportion to the amount of lime used and therefore it was considered of little use to add lime to the concrete.

In the course of the actual work on the standpipe



Curves for Aggregates Used for Westerly Standpipe.

centages retained on the screen; 1-in., 1½ per cent; ¾-in., 5½ per cent; ½-in., 15½ per cent; ⅜-in., 20 per cent; ¼-in., 26½ per cent; 3-16-in., 31 per cent; ⅛-in., 38 per cent; No. 8 screen, 39 per cent; No. 20 screen, 62 per cent; No. 30 screen, 81½ per cent; No. 50 screen, 95 per cent; No. 100 screen, 98 per cent; No. 200 screen, 100 per cent.

The fine sand known as No. 5 when screened gave the following results: ½-in., 2½ per cent; ⅜-in., 5½ per cent; ¼-in., 9½ per cent; 3-16-in., 12½ per cent; ⅛-in., 17 per cent; No. 8 screen, 18½ per cent; No. 20 screen, 37 per cent; No. 30 screen, 65 per cent; No. 50 screen, 91½ per cent; No. 100 screen, 97 per cent; No. 200 screen, 99½ per cent.

The fine sand, No. 5, did not seem, however, to be as good quality as the coarse sand, there being a considerable amount of dirt in it so that it was decided not to use this.

Three samples of stone were then tested and of

volumetric tests were not made every time samples were analyzed, but only when they varied 2 or more per cent from those in use was the curve of the mixture worked out. As the sand and stone used were measured in wheelbarrows the quantity was subject to an unavoidable variation of 2 or 3 per cent so that it was believed to be an unnecessary refinement to carry the curves to any greater accuracy.

The amount of water added was given a great deal of consideration. It was found that the percentage of water added to concrete in mixing has a very marked effect upon its permeability and that even very slight variations from the proper constituency give much greater variations in permeability, that is, if too much water is added the resulting concrete is much less waterproof than one with the ideal amount of water. This ideal amount varies, however, for different mixtures of cement and aggregate, and the nearest approximation that can be made offhand is that enough water shall be added to make a mixture which under tamping shall show water at the surface and give what we call a dry quaking mix, that is a mix that will not quake until it has been thoroughly tamped. With any given cement and aggregate, preliminary tests may readily be made to determine the proper

DISINTEGRATION OF CONCRETE IN SEWAGE DISPOSAL TANKS.

The Engineering Experiment Station of the Iowa State College is now investigating the disintegration of concrete in sewage disposal tanks, and members of its staff are being sent to places, in Iowa particularly, where such disintegration is reported. A preliminary report on this work was presented by Mr. W. M. Barr, chemist of the experiment station, before the recent convention of the Iowa Association of Cement Users, and is abstracted herewith.

The disintegration of concrete in sewage disposal plants was called to their attention about two years ago, when such condition was observed in the dosing chamber of the septic tank at the State Hospital for Inebriates at Knoxville, Ia. In addition to this disintegration large quantities of hydrogen sulphide were given off whenever the dosing chamber discharged. The disintegration in this plant, as in other cases observed, occurred above the water line in the dosing chamber. At a later date Mr. Barr observed that the sewage disposal plant at Grinnell, Ia., showed a condition similar to, if not identical with, that at the Knoxville institution.

In these two cases it was observed that the water



Medusa White Portland Cement used for Exterior Plastering of Fifty Houses at Hull, Garden City, England.

amount of water to use in mixing. Once the amount which gives a dry quaking mix has been found it is simply a matter of adding this proportion of water to each batch of concrete.

In the actual mixing of the concrete on this job we followed a method somewhat different from our usual one. One half of the stone was put in the mixer and some water. The mixer was then revolved for a minute or so and the sand and cement and the rest of the stone and water were added. The concrete was then thoroughly mixed for a total time of about five minutes, when the mixture was dumped and hoisted up onto the tower.

The tests described were conducted by Mr. W. W. Clifford of the Aberthaw Construction Company.

supply carried high mineral content and that the sulphates were high in both, as the following analyses, which are expressed in parts per million, will show.

	Solids on Evaporation	Solids on Ignition	Sulphates
Hospital for inebriates.....	2,690	2,670	1,645
Grinnell	1,066	1,018	476

Seven other sewage disposal plants, built along similar lines, have been observed by Mr. Barr and in all there is neither excess of hydrogen sulphide nor any disintegration of concrete and the highest sulphate content in the water supplies is 51 parts per 1,000,000.

These observations seem to point to a relation between the mineral sulphates of the water supply and the excessive hydrogen sulphide evolved in the process. Analyses of the raw sewage and the effluent were made to determine the sulphates in solution, together with the total sulphur in the raw sewage. These results indicate, first, that the organic matter in normal sewage does not contain enough sulphur to produce the hydrogen sulphide observed in this case, and, second, that

where the sulphates in the original water supply are high there is a reduction in the amount of mineral sulphates found in the effluent, showing that a portion of these mineral sulphates must have been reduced and assisted in producing the hydrogen sulphide observed. The moisture upon the walls of the dosing chambers where disintegration occurs contains a considerable amount of sulphur and all of the lime content of the cement, near the surface, is converted to calcium sulphate. It is evident, then, that the agent producing the disintegration is sulphuric acid and that this sulphuric acid comes from the hydrogen sulphide. It is well known that the oxygen of the air will convert hydrogen sulphide to sulphuric acid, but it seemed improbable that the amount of acid here formed could result from this action.

At this point Dr. R. E. Buchanan, of the Iowa State College, took up the bacteriological study of the problem. He found that normal sewage contains bacteria which have the power of reducing mineral sulphates with the liberation of hydrogen sulphide. He identified these bacteria in the sewage taken from the tanks mentioned and proved by experiment that they would reduce the mineral sulphates occurring in water. This then accounts for the formation of the large quantities of hydrogen sulphide found in sewage disposal plants where highly sulphated waters are used. His attention was then turned to the walls on which the disintegration occurred, where he found, on examining what appeared to be a sulphur deposit under the microscope, a mass of sulphur granules mingled with living organisms. Many of these were evidently feeding upon this sulphur, as the sulphur granules were identified within their bodies. Among these bacteria was identified at least one form (and there were probably others) which is known to convert hydrogen sulphide and sulphur to sulphuric acid. This, then, supplies another important factor in the production of the sulphuric acid which is the direct cause of the disintegration. These facts, I believe, establish the relation between the formation of the excessive hydrogen sulphide and consequent disintegration of the concrete and the character of the original water supply.

Mr. Barr hopes in the complete report to add further evidence to this case by investigating similar situations as they may be discovered. It will then remain to suggest a method for the disposal of sewage where heavily sulphated water is used without producing a nuisance from the foul odors arising or injury to the plant from the breaking down of sound concrete.

A STUDY OF THE NATURE OF CEMENT.

The Chemistry and Testing of Cement.—By Cecil H. Desch, D. Sc. (Lond.), Ph. D. (Wurzb.), Graham Young Lecturer in Metallurgical Chemistry in the University of Glasgow. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 5½ x 8¾ ins.; pp. 267; five plates, 19 text figures and 33 tables. \$4.00.

The present work is written from the point of view of the chemist, and mechanical processes are only so far described as is necessary to render the account of the manufacture (of cement) intelligible. References are given to larger works in which the engineering aspect of the industry may be studied. The attempt has here been made to explain the nature of the chemical compounds contained in cements, the reactions involved in their preparation from the raw materials, the

changes which take place during setting and hardening, and the methods of controlling the quality of the product. The author has sought to present as fairly as possible the results of modern research, passing over the older loose and inaccurate views which are still frequently reproduced in many works of reference.

Possibly no other material so widely used as calcareous cement is so little understood. Most engineers have a fairly clear idea of the methods of manufacture and of the constituent parts of the raw material, but their knowledge of the chemistry underlying either its manufacture or its setting is of the vaguest. This is not to be wondered at considering the very vague notions the chemists and the cement makers themselves have of the nature and behavior of their product. It has only been in the past decade that the growing science of physical chemistry has combined its research with the older pure chemistry to clear up some of the underlying fallacies in the old theory of cements and even now the sum total of knowledge about it is very meager. With the advanced methods of research now being pursued in several laboratories we can hope in the not too remote future to have a basis of theory which may quite probably appreciably affect the future manufacture of cement and improve the quality of the material engineers use.

Meanwhile it is desirable that the present state of knowledge be set down as clearly as possible, and this has been very fully done by Dr. Desch.

The preliminary chapter is a historical one, somewhat different from similar chapters in analogous books, because it discusses the chemical makeup of the earlier cements and limes and traces slightly the development of the study of cement chemistry. The second chapter is a standard discussion of the raw materials and the processes of making various types of cements. The third chapter takes up in detail the chemical components that go to make up cements, treating each compound separately and discussing its physical and chemical nature. Here the latest developments in the study of the calcium-aluminum-silica compounds are set down.

Chapter IV. is devoted to the constitution of cements, with special attention to a microscopical study of thin slides of hardened cements and cement mortars. Chapter V. is on the setting and hardening of cements. Chapters VI. and VII. take up the physical nature of cements, mortars and concretes, and include all the material on the testing of cements which gives the book a portion of its title. Chapter VIII. the various distinctive agencies that affect hardened mortars or concretes and the final Chapter IX, the question of Chemical analysis to determine the composition of a finished cement. Appended is the Revised British Standard Specifications for Cement.

The portions of the book devoted to concrete, as a material for the engineer's use, are not of any great value. Quite evidently they are not from the author's own knowledge, but are mere restatements of what other men have said. On the other hand, the original purpose of the author has been remarkably well carried out. The insistence throughout that cement must be regarded as a metallurgical problem, similar of course in line with accepted theory to-day, but it serves to clarify considerably what can never be a very clear matter, especially to the layman or even the engineer. Primarily the book is intended for cement chemists, but very conceivably the engineer who is interested in cement or in concrete could get much of interest and value to him out of it. Especially good are the sections on the effect of sea-water, alkali, sewage and other deleterious matter on hardened concrete.

THE CONCRETE HOUSE THAT TOOK THE PRIZE.

As the prize to the winner in the guessing contest at the Third Annual Cement Show, held in February, 1910, in the Coliseum at Chicago, Miss Lillian M. Williamson was given the material for a cement house. She was to build it wherever she wished, but with the materials furnished by the exhibitors. The house is being built in Walden, a pretty suburb of Chicago, and was designed by Francis M. Barton, of Chicago.

Concrete is being used throughout the building, all the walls and partitions being of concrete structural

will consist of a simple moulding around the house at the second floor level; and to relieve the plain concrete wall monotony there is a moulded cornice.

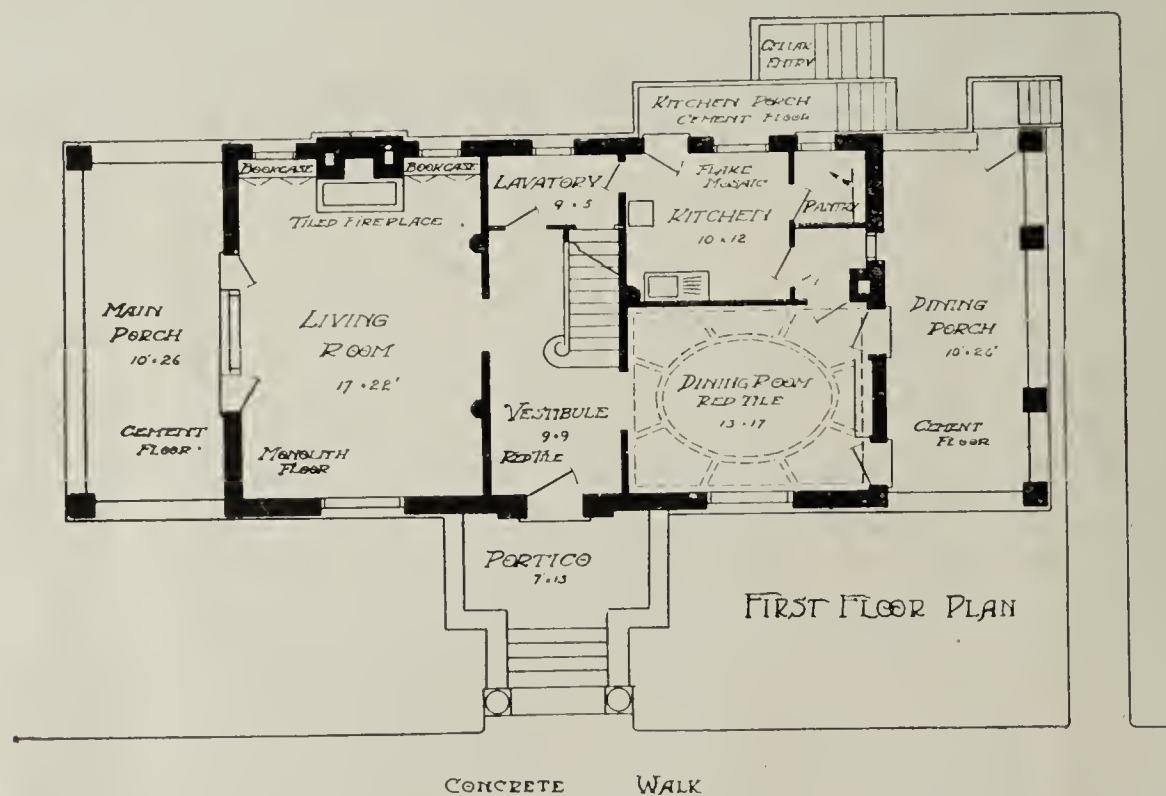
The house as designed is to contain many interesting features. The living room floor is made of a new composition and is easily kept clean and not unpleasant to the touch. Besides these points, it is softer than either plain concrete or tile. It is decorated with a conventional border and is plain of color. The vestibule and dining room floors are of red tile with one-half inch black joints. The kitchen and the rooms upstairs have floors of flake mosaic, which makes a background to harmonize with the room furnishings. The baseboards



tile manufactured by the Chicago Structural Tile Company, insuring protection and insulation from both heat and cold. They are finished with a rough coat of cement plaster. Every floor and stairway is built following the rules of Mr. Barton's reinforced concrete system. The foundations are of plain, solid concrete.

are carried up to a border and are all made of the same material as the floor. The two fireplaces have window seats on both sides and there is a hearthstone of red tile in front. There is a large mantel, and this and the fireplace are both made of solid reinforced concrete with a moulded decoration.

DINING ROOM
MONOLITH FLOOR



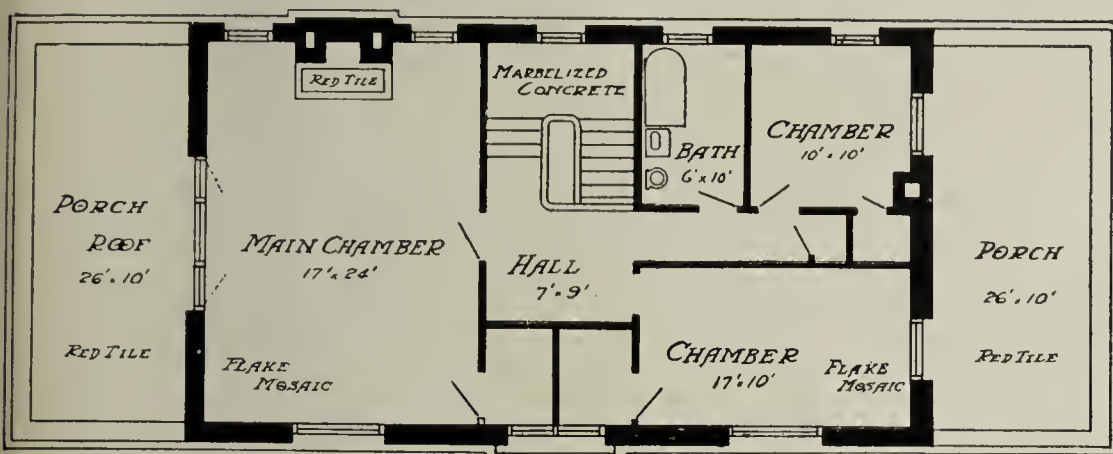
There are two concrete chimneys surmounted with round tops; the roof is of red tile.

The house has an entrance portico in the center and a screened porch at each end. The exterior decoration

It is common now for people to spend three-fourths of the year on their porches instead of in the house. This custom can be gratified by the occupants of the prize house, for it has two spacious porches, one open-

ing off the living room and the other off the dining room. These porches are not connected with the entrance portico, thus giving the full privacy of an interior room with the advantage of screened exposure on three sides. The entrances to the porches are through two large French doors, which when opened make the porch a unit with the inner room.

The house is in every way modern. Nothing has been attempted in structure or decoration which does not harmonize in concrete. The flat arch is used in the doorways and all beams and columns in the house are plainly exposed to view, the aim being to show the value of true concrete construction in the highest example and to show the concrete decoration throughout the building.



SECOND FLOOR PLAN

LAYING WOOD PAVING WITH CEMENT-GROUT CUSHION ALONG STREET CAR TRACKS.

A difficulty which attends the use of wood block paving, is that of adjusting and supporting it effectively at such breaks in the pavement as are caused by manholes, sewer inlets, street railway rails, etc. The greatest amount of trouble occurs at the rails, as they form a continuous break in the center of the street, where traffic is most congested. The manholes and inlets are scattered and are placed where they are subject only to an average amount of traffic. This matter has been investigated by Mr. H. G. Davis on behalf of the Chicago Street Improvement Association, and the following information is taken from a report on the investigation.

The trouble at the rails is due to the following causes. (1) vibration caused by the movements of cars, (2) leakage of water into the sand cushion by passing between the rail and the paving, (3) the heavy stress to which the paving is subjected due to concentration of traffic upon it. Under these conditions, where any block pavement (wood, brick or stone) is laid upon a sand cushion a special treatment is needed to prevent the sand from being washed or jarred out of place, and a consequent settlement of the paving. This settlement, however slight, is disastrous to any pavement, and especially so for wood block paving. As soon as blocks settle, the paving begins to get the pounding effects of heavily loaded vehicles and a rut is produced.

The vibration alone will tend to shift the sand, but when water gets into the sand the latter becomes extremely mobile and the movement is accentuated. The vibration has also a pumping effect upon the saturated sand, and may cause it to flow to the surface of the pavement. Should this saturated bed of sand become frozen, it is likely to heave to such an extent as to cause damage to the pavement. To reduce the jarring, the joint along the rail should be fitted as perfectly as possible, so that wheels of vehicles will not drop or

climb in passing from the rail to the pavement.

The remedy for the shifting of the sand and consequent settlement of the paving is believed to be in the treatment of the sand cushion. About five years ago, the South Park Commission (Chicago) began using wood block paving for intersections of parkways with streets having car tracks, and laid the blocks on a cushion of cement grout instead of sand. This paving has proved successful under heavy traffic. The plan suggested, therefore, is to use this sand-cement grout instead of sand for the cushion bed between the rails and for at least 12 ins. outside the rails. This cushion will not be affected by water or vibration. This arrangement is not entirely new, and is included in the plans prepared some time ago for Chicago street-railway track construction with brick pavement (*Engineering News*, Nov. 3, 1910). In this case, however, the grout cushion is used only for a strip on each side of each rail.

It is recommended that a dry mixture of 1 part Portland cement to 3 parts sand should be made, and spread in the same way as the ordinary sand cushion. The blocks are laid upon this and tamped. Then the paving is flushed thoroughly, so that the water will pass through the joints and interstices and saturate the sand-cement base. It is best to keep traffic off the pavement for 24 or 48 hours, in order to give the grout time to set. It is said that this is not absolutely necessary, however, as even if the traffic is admitted immediately, the material will "cake" sufficiently to be superior to a sand cushion. The additional cost is said to be very slight. This grout cushion may be used with either wood, brick or stone block paving; it may be used also around manholes, etc., if desired.

Another difficulty experienced where wood block paving is laid between the rails is the development of transverse ruts or grooves at the tie-rods which hold the rails together. This is due to the wide joint, and it is suggested that where such rods are used, the blocks should be chamfered so as to permit of making the usual close joint. This would cause a little trouble in laying the pavement, but not enough to add materially to the cost.

PERMEABILITY OF CONCRETE AND SOLUBILITY OF AGGREGATES.

Tests on the permeability of concrete and the solubility of aggregates were made during 1909 by the Board of Water Supply of the City of New York, which has published in its latest annual report a summary of the work accomplished. Studies were made of the effects of various fine materials incorporated in the matrix of concrete, in reducing permeability, including clays, hydrated lime, and puzzolan and sand cements, these two cements being more finely ground than Portland cement. The conclusion was reached that concrete, practically impervious under 200-ft. head, can be produced with any of these materials, but that equally good results can be secured by using sufficient Portland cement, the latter method having the advantage of securing concrete of increased strength, while the other materials usually reduce strength.

A series of tests was made on the solubility of various rocks used as concrete aggregates on the work, particularly limestone and others of the more soluble rocks, to determine their fitness for concrete which might be subject to the solvent action of percolating water. Cylindrical specimens of concrete 8 in. in

diameter and 6 in. in length were exposed for a period of eleven months, to the percolating action of Croton water under a pressure of about 22 lb. per square inch. Each specimen was incased in a neat Portland cement mortar, 2 in. thick, except on the bottom, so as to give the water access only to the full end area and compel the entire flow to pass through it. The upper end, under the mortar cover, was covered with a layer of sand, 1 in. thick, through which the water flowed from the pressure pipe. The bottom was free. The proportions used in the concrete were 1 part Portland cement, $3\frac{1}{2}$ parts crushed quartz and 6 parts broken stone. The proportions were measured by weight.

Periodic analyses of the water coming through the specimens indicated, by changes in mineral content, a rapidly diminishing rate of solution, the solvent action practically ceasing after five months. Specimens containing granite and quartzite aggregates showed higher rates of solution than any of the limestones, with one exception. A strongly magnesian limestone showed the highest resistance of all in the series. The rate of leakage in all specimens decreased rapidly during the first six weeks and at a slower rate thereafter. The analyses of the percolating water seemed to indicate that whatever solution occurs within a mass of concrete affects chiefly the cement.

BUSINESS AND BUSINESS MEN.

By W. B. Jackson.

Some inside history in regard to the selling of bonds and other securities of heavily capitalized and extensively advertised industrial propositions is given in the petition filed for a receivership in the affairs of the Peoples Portland Cement Company of Sandusky, in which a number of Columbus and central Ohio men are interested through the purchase of bonds.

The company is incorporated under the laws of Washington with a capitalization of \$2,000,000 and was organized by Arthur G. Ford, formerly of Springfield, but now of Chicago. The company took over the Lake Shore Cement Company of Sandusky, for which \$250,000 in bonds and \$50,000 in stock of the Peoples Company were given. The bonds were to be sold by the Peoples Company to complete and equip the Sandusky cement plant and also one at Spokane, Wash.

The petition alleges that Ford was in charge of the sale of the bonds and sold, altogether, \$134,000 of the bonds, but in doing so, incurred for advertising and general expense \$89,000 and also a further indebtedness of \$21,000, making it cost the company to sell \$134,000 of bonds over \$110,000. Ford is also said to have taken over \$100,000 of the bonds himself and out of the proceeds of the sale of the bond issue but \$56,000 went into the property and the company, as a result, is indebted, according to the petition for the receivership, over \$75,000.

It is also alleged that Ford, through his control of the board of directors, was about to complete a contract with the company to open offices in New York for the sale of the bonds and was to receive for all bonds sold 25 per cent commission and also a bonus of the stock. The Sandusky plant, when completed was to have a capacity of 1,000,000 barrels of cement a year. Prospectus promises of great profits to be made in the cement business induced many men to put their money

into the securities of the company and they now learn that to sell the bonds cost two-thirds of their face value, about one-third, according to the petition, going into the property.

There have been many lessons of this kind given in Columbus and central Ohio, but promises of large and quick profits always blind the eyes of the investor to the chances he is taking. There are many growing industries in Columbus which are needing additional capital and the owners of which would put every dollar invested in their business into the plant, but they are passed by for schemes of which the investor knows nothing and of which he can learn nothing, except the statements made by the seller of the securities, who is much more interested always in the commission he will receive than in the ultimate success of the proposition.

PROTECTION OF CONCRETE SURFACES.

One of the most important questions that presents itself to-day to the contractor, engineer and architect is that of taking care of cement surfaces along protective, decorative and dampproofing lines. Cement surfaces dry out with an unevenness of color and they often set ununiformly, causing a variation in texture or hardness of the surface which causes disintegration in cement floors, due to frictional wear.

Due to the fact that cement construction has assumed such enormous proportions, in keeping with the progressive spirit which has been the keynote of the success of the Glidden Varnish Company, of Cleveland, Ohio, about three years ago they turned over to their research and chemical laboratories the investigation of suitable materials to be blended for the purpose of producing perfect mediums for the treatment of cement surfaces along protective, decorative and dampproofing lines.

After exhaustive tests conducted by the best research chemists, assisted by practical cement workers, they have brought out a most excellent line of materials, covering every requirement of the architect, contractor and engineer for the treatment of concrete surfaces. The following information will be of great interest and value to the architects, engineers and contractors, and we are able to reproduce this information through the courtesy of the Glidden company. The products which make up their elegant, complete line of concrete finishes are briefly stated as follows.

Concrete floor dressing, which is applied to cement floors by means of a brush, protecting the floors from dusting and abrasion due to frictional wear, preventing absorption of water, grease, oil and disease germs. Two coats were used, applying the material over a clean, dry surface. The product is made in light and dark drab, terra cotta and tan colors, also transparent. For factory floors Transparent Concrete Floor Dressing is very much preferred, while for floors of schools, hospitals, office buildings, and similar buildings, the colored Concrete Floor Dressing is mostly used. Glidden's Liquid Cement is especially intended for uniforming the surface color of concrete, cement stucco, brick and stone. This material also dampproofs the building, and besides producing a pleasing decorative effect, insures a dampproof building. This material is applied by means of a brush—the same as any paint or varnish.

Another product that is being used very largely is Glidden's Transparent Waterproofing, which is in-

tended for dampproofing brick, concrete and cement construction without changing the color or texture of the surface. This is the most efficient dampproofing medium that has ever been developed. They also make a material known as Liquid Rubber, which is especially intended for use upon exterior surfaces of substructural work with the view of preventing the inroads of dampness into basements. This material is applied by means of a brush, two coats being used. Liquid Rubber is also used upon interior surfaces of exposed walls applied directly to the brick or wall construction, previous to plastering, thus affording a perfect waterproof bond between the plaster coat and the wall proper. Liquid Rubber thus applied prevents the inroads of dampness through the plaster and protects the wall decorations from disintegration, staining and injury. This material carries a special merit along these lines.

One of the most successful products which the company has brought out is known as Glidden's Waterproof Flat Finishes, especially developed for the interior treatment of rough and smooth plastered walls, interior cement and composition surfaces. These flat finishes

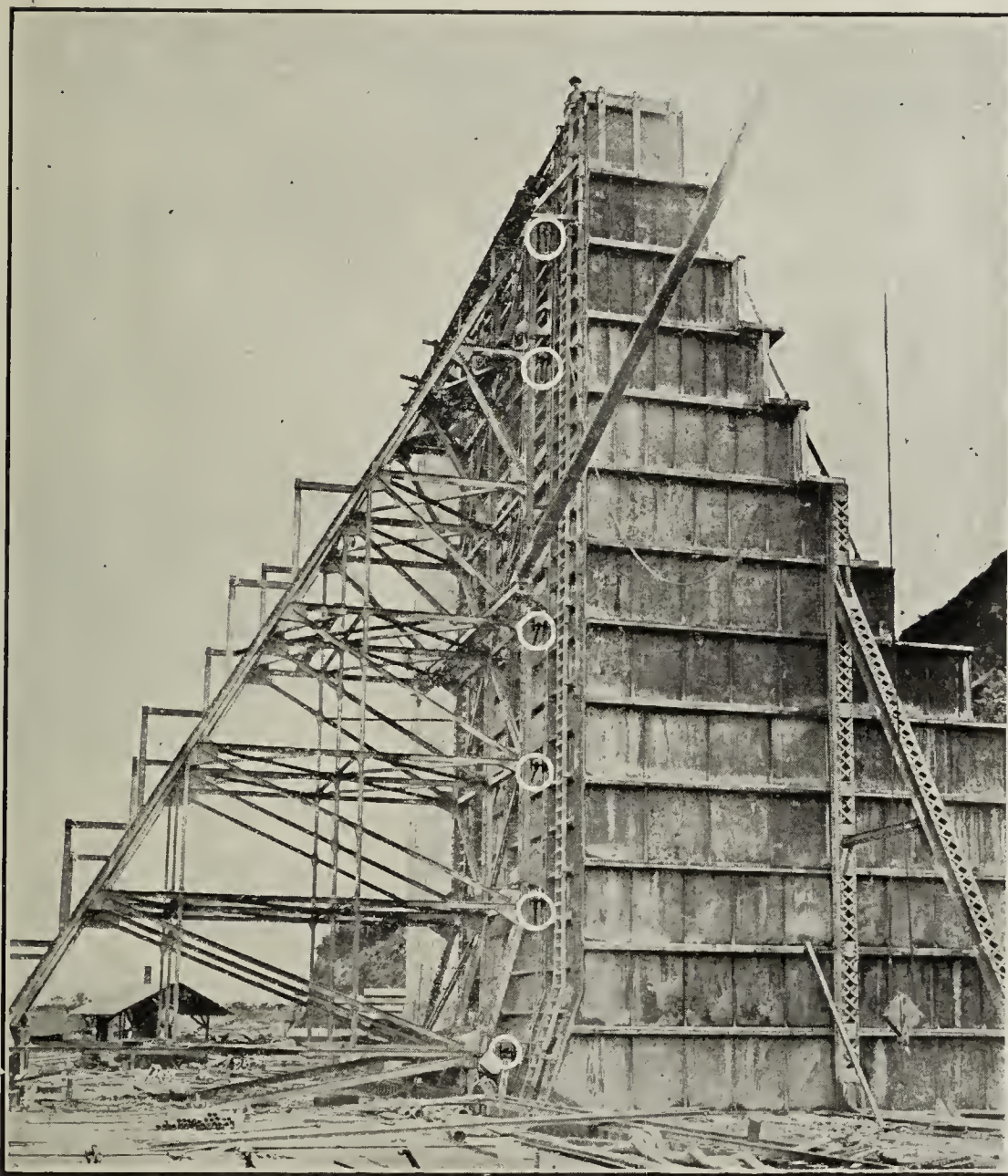
architects, contractors and engineers who are interested in having the valuable information which is conveyed through the medium of their booklet.

If you have any unsettled questions in your mind relative to the treatment of cement and plaster surfaces, either exterior or interior, you will be well repaid by taking up such subjects with the Glidden people, who we feel assured can be of great value to you in determining the best methods of treating such surfaces along protective, decorative and dampproofing lines.

RATCHET JACKS PLAY BIG PART IN PANAMA CANAL CONSTRUCTION.

One of the indispensable tools that is aiding in the construction of the Panama Canal, is the Jack. Gigantic steam shovels and other mammoth machinery that are being used in the digging of the "big ditch" are important, but in the concrete work necessary for the miles of cement dams that will make possible water travel between the Atlantic and Pacific Oceans, Jacks are taking a highly important part.

Hundreds and hundreds of Jacks have been furnished



View of Steel Forms at Panama Canal in Building Concrete Dams, showing the Jacks used to line-up and hold in position the heavy steel plates.

produce a washable, sanitary finish in soft, rich tones, far more refined than the old lead and oil treatment of walls. The Glidden Varnish Company has just issued its latest booklet on "Advanced Finishes for Modern Building Construction," which fully described the above products and the other materials which they have developed as pertaining to modern building construction, covering concrete and steel structures, and it will be an unusual pleasure for the company to forward, without charge, a copy of their booklet to all

to the Isthmian Canal Commission under contract, but the most important single shipment, which has been made to the canal zone, consisted of two hundred and seventy-six Jacks of special construction, manufactured by the Duff Manufacturing Company, Pittsburg, Pa. These Jacks are being used in the actual building of the giant dams at the various locks.

The Jacks were built on entirely new models and especially for this work, under special specifications furnished by the canal commission's engineers. The

order amounted to thousands of dollars and every Jack was thoroughly inspected by government engineers.

The Jacks weighed an aggregate of more than 23 tons and had a total capacity of 4,500 tons. Hundreds of thousands of tons of concrete have been formed into dams and the work is going steadily on. Each dam is approximately the height of a six story house and is 1,000 feet long. Two hundred and fifty-two Jacks, each weighing 165 pounds, and each having a capacity of 15 tons, formed the greater part of the special shipment made by the Duff Company. In addition there were 24 Jacks, each weighing 220 pounds and each having a capacity of 30 tons.

The Jacks are used to line-up and hold in position a gigantic steel plate, while the concrete dam behind it is "setting." The plates are bolted to a huge "A" frame of structural steel work, which is 78 feet, 4 inches high, 24 feet wide and 40 feet in depth on the ground level. Each frame is in the shape of a right angle triangle.

There are 12 frames in use by the Isthmian Canal Commission. They are termed travelers and operate on tracks in order that they may be shifted from one section of a dam to another. They are portable and serve for lining up the dams in every lock under construction. The solid steel plate attached to each is the same height and width as the traveler and is placed on the inside of where the concrete wall of the dam is to be constructed. As the concrete is set in the forms behind it—the forms being the same height as the traveler and 30 feet deep at the bottom—the traveler plate is forced against it and the Duff Jacks are hitched between the frame and the plate. They are then

the plate is enormous and the entire weight is borne by the Jacks. It is estimated that the entire pressure against each frame is 1,000 tons or 2,000,000 pounds.

Three 30-ton Jacks are hitched in the traveler near the ground, where the pressure is greater, while 30 15-ton Jacks are hitched at various spots up and down the two outside and center trusses of the traveler. As there are 12 travelers, those in charge of the construction have been able to operate 8 travelers with Jacks at the same time. In this manner the concrete work is being rapidly rushed to completion. As each lock is 1,000 feet long and many are of the double lock type, necessitating several thick concrete walls on both sides of the canal, the enormity of the contract is apparent.

Other Jacks in large lots were furnished by the Duff Company, for work on other parts of the canal. Between 500 and 600 track Jacks for changing the various tracks for the portable railways, that haul the cement and other material to and fro, were furnished. In addition the government uses several hundred Duff ball bearing screw Jacks for the steam shovels.

CONCRETE SURFACES.

One of the recent publications of the Universal Portland Cement Co. of Chicago and Pittsburg deals with the artistic finishes that can be given the surfaces of concrete walls or any concrete work that is expected to become an ornament.

The various methods employed, as for instance brushing or rubbing of the concrete surfaces, bush hammering the surfaces or the application of sand blast or of an acid wash, all aim to remove the cement from the surface layer of concrete and to expose the coarse sand or crushed stone.

Beautiful effects can be obtained by such treatments, as all know who have studied samples of similar work exhibited at Cement Shows. For the convenience of contractors and builders who had not the good fortune of attending one of the annual exhibitions, this book contains plates showing in natural colors samples of the most artistic effects obtainable by the application of pebbles or black and white marble chips or crushed granite of varying colors.

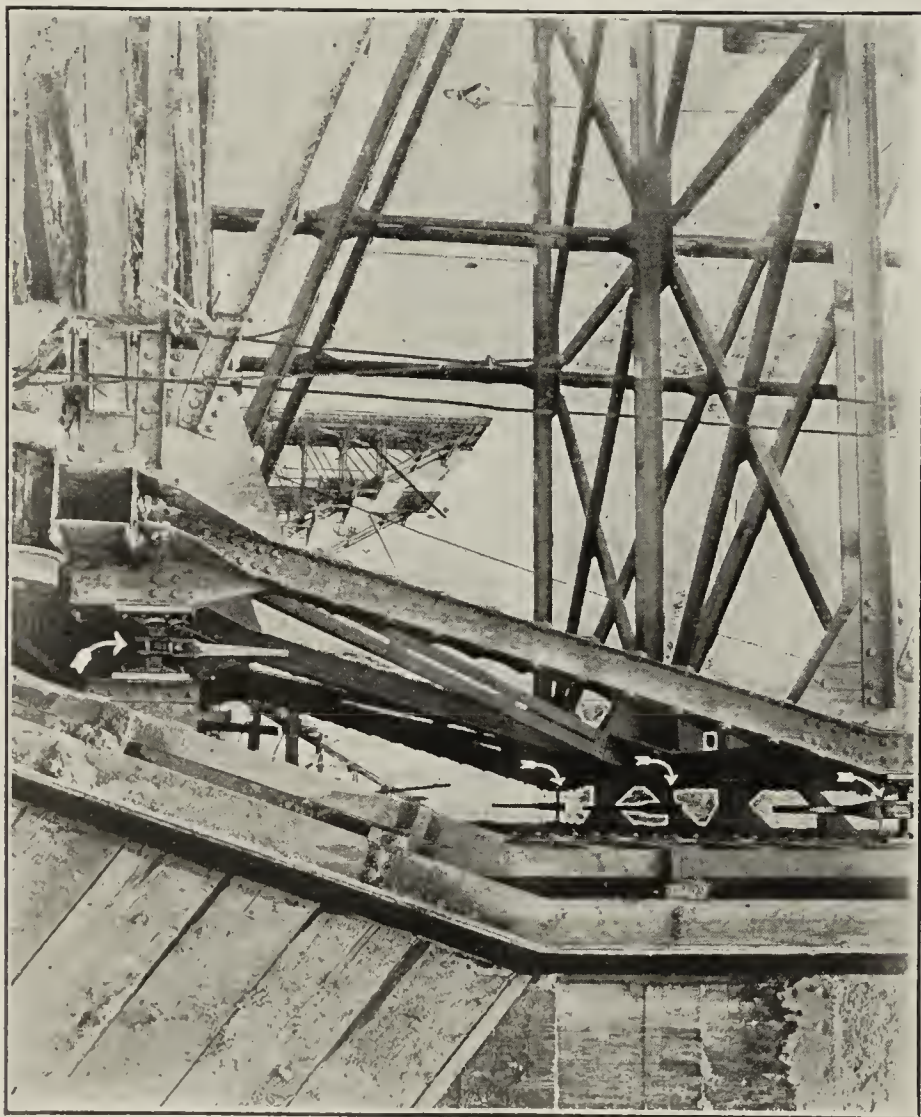
Several of our large cities possess a great number of specimens of similar work, as for instance bridges, park benches and lamp posts. These are illustrated in the publication and a special chapter is added in which interested parties will find the exact cost of each of the methods described.

MCCORMICK WATERPROOF PORTLAND CEMENT CO.

Due to the increase in business west of the Mississippi River, the McCormick Waterproof Portland Cement Co. of St. Louis, Mo. have opened another office in Kansas City, Mo., Reserve Bank Building, Room 332. Wm. H. K. Bennewitz has been appointed Special Representative of the Company in that territory.

The McCormick Waterproof Portland Cement Co. has now seven offices located in the following cities, viz., St. Louis, Mo., Chicago, Ill., New York City, Boston, Mass., Pittsburg, Pa., Toledo, Ohio, and Kansas City, Mo.

Portland Cement made Waterproof by the McCormick Process produces a concrete that will resist any waterpressure to which concrete structure is subjected, it will resist the action of alkalies, sewer gases, steam, acids in solution, and sea water. The McCormick Waterproofing Compound is mixed with any brand of



tightened, lining up and holding in position the newly set concrete.

The Jacks are of double screw type, there being a right hand screw on one side and a left hand screw on the other, with a ratchet between. As they are tightened, they spread the plate, which is forced against the water side of the concrete dam. The pressure on

Portland Cement right at the cement mill and is used on the job exactly like plain Portland Cement; this is an essential factor, for it eliminates altogether the equation of labor.

A feature of interest to all is the cost, the McCormick Process of waterproofing has reduced this item considerably.

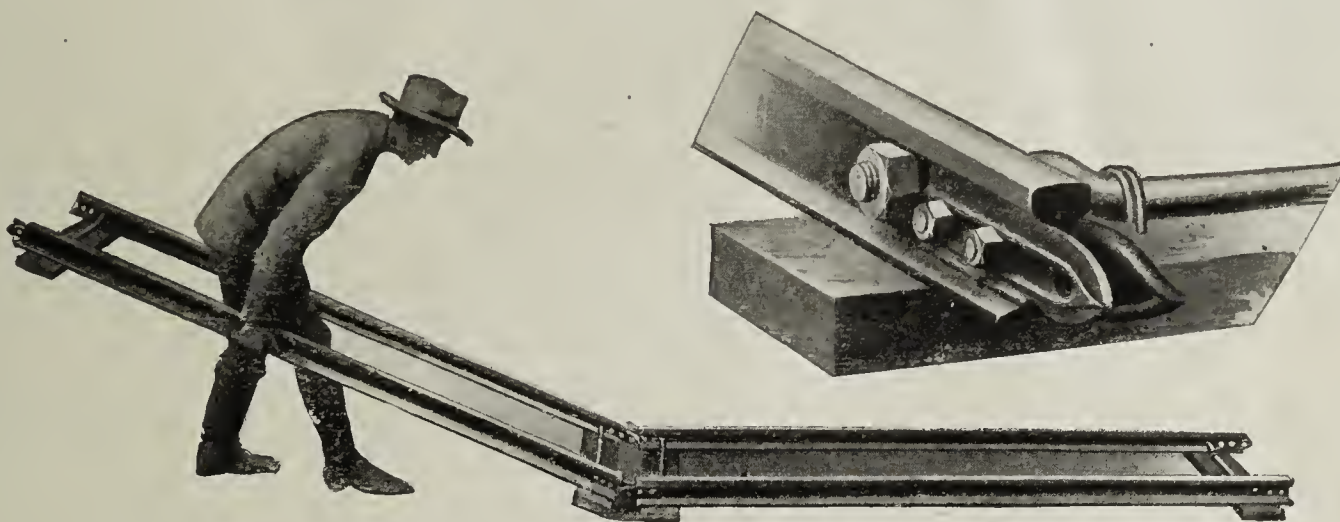
The above mentioned qualities are possessed only by the McCormick Portland Cement and account for the increased demand.

Write for reports and tests to the nearest office of the McCormick Waterproof Portland Cement Co.

they project beyond the end of the rail forming a socket. Into this socket is put the free end of the next rail. The rail is secured to the tie by two bolts which add to the strength of the joint and prevent loosening or loss of any parts when the whole track is being shifted.

The whole operation much resembles putting together a jointed fishing rod, from which fact can be gained an idea of the rapid work possible. If at any time a permanent track is desired the addition of a third bolt to each section is all that is required.

From the foregoing description it will be seen that one man alone can lay a track almost as quickly as



A NEW IDEA IN PORTABLE TRACKS.

A very simple yet remarkably effective rail joint now on the market permits the laying of portable track at a speed only limited by the number of men employed at the work.

To one end of each rail an angle joint is attached,



the joint being composed of two pressed steel brackets which are formed into an angle held in position and permanently connected to the rail by two bolts so that

three men could lay the necessary ties in other portable track systems.

In construction work in which time is usually the essence of the contract, the use of the track assures big increase in the amount of work done. On many big jobs which usually employ heavy permanent tracks, this type is used as an auxiliary equipment saving much valuable time and requiring but few men to handle it.

The Orenstein-Arthur Koppel Co. of Pittsburgh, Pa., which makes this track, reports a large demand for the new rail.

100,000-BARREL CEMENT ORDER.

The Tennessee Coal, Iron & Railroad Co. of Birmingham has closed a contract with the Standard Portland Cement Co. of Birmingham for 100,000 barrels of Portland cement, to be used principally in the construction of Edgewater dam. The Standard plant is located at Leeds, Ala., and the quality of cement manufactured is offered as fulfilling the most rigid tests and specifications.

Jeffrey Pivoted Bucket Elevator-Conveyor

For handling Cement, Crushed Stone, Coal, Clinker and Ores.



Built for hard continuous service and always up to their maximum capacities. Write for particulars.

Manufacturers of Revolving and Shaking Screens, Crushers, Pulverizers, Rubber Belt Conveyers, Tray Elevators, etc. Catalog 81 describing these lines mailed upon request.

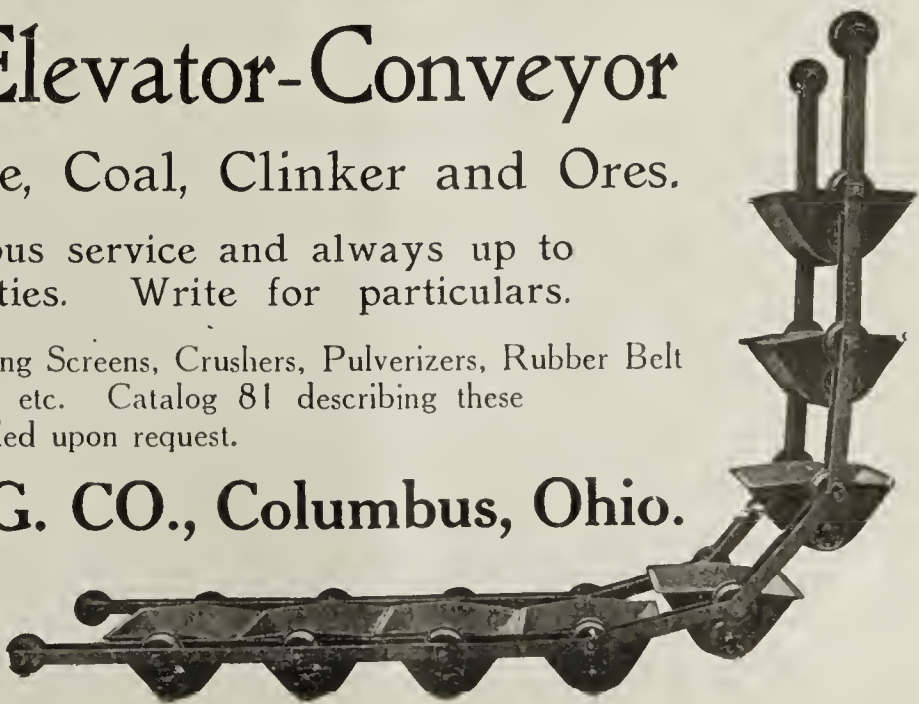
The JEFFREY MFG. CO., Columbus, Ohio.

Pittsburg
Atlanta, Ga.

Boston
New York

Chicago
St. Louis

Denver
Montreal
Birmingham
Charleston, W. Va.



CEMENT PRICES.

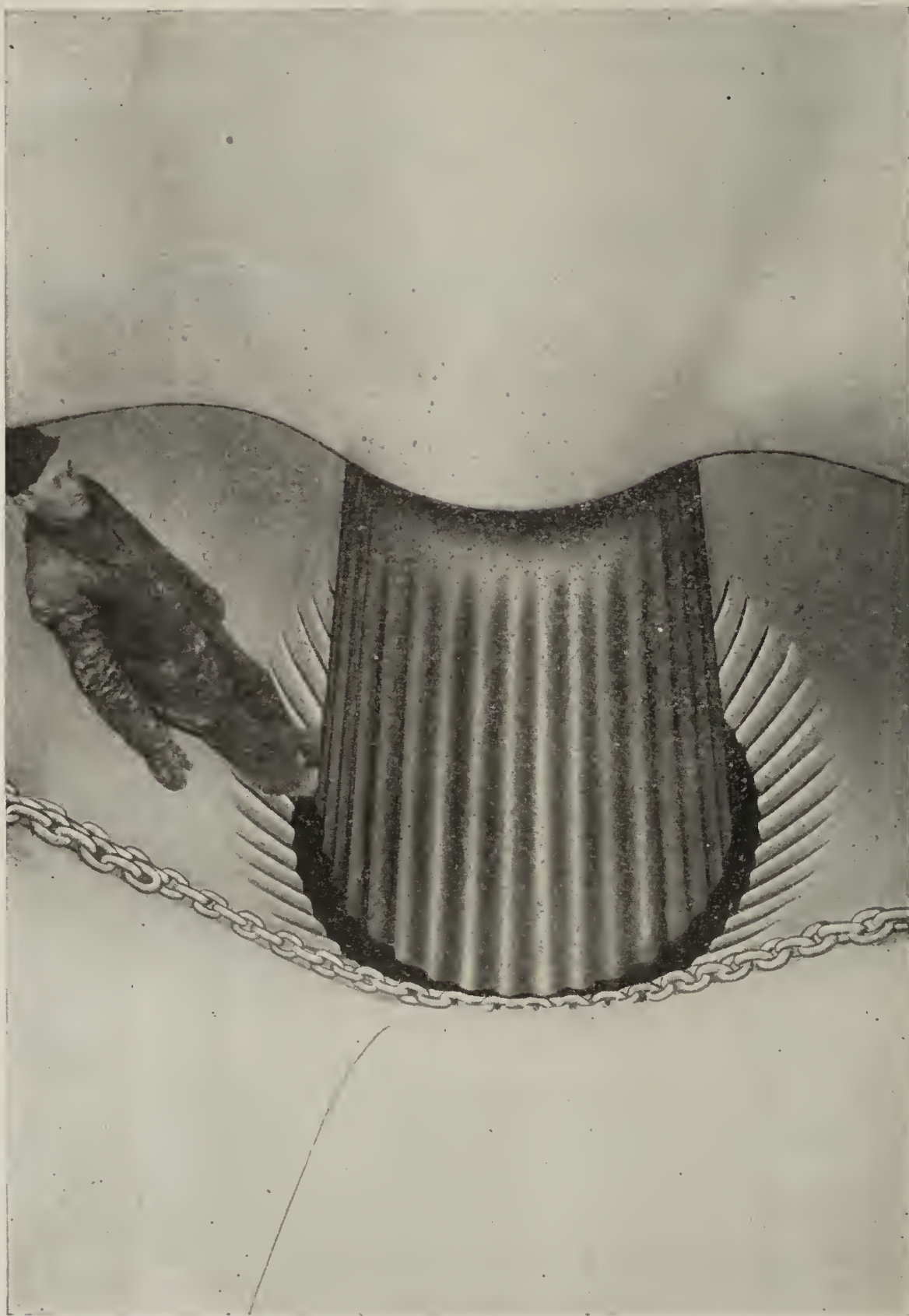
Bids were received as follows, recently by the Superintendent of Prisons, Dept. of Justice, Washington, D. C., for furnishing 8,000 bbls. of Portland cement at the U. S. penitentiary, Leavenworth: Union Sand & Material Co., Kansas City, Mo., \$1.15 per bbl.; sacks, 10 cts. Western States Portland Cement Co., Kansas City, \$9,440, and 10 cts. The Bonner Brand Portland Cement Co., Kansas City, \$9,840, and 10 cts. The Dewey Portland Cement Co., Kansas City, \$8,800, and 10 cts. The Iola Portland Cement Co., Kansas City, \$9,040, and 10 cts. The United Kansas Portland Cement Co., Kansas City, \$9,040, and 10 cts. Ashgrove

CHICAGO PORTLAND CEMENT CO.

"From The Raw To The Finished Product" is the title of a publication issued by the Chicago Portland Cement Co. describing the process of manufacture and the machinery of the company's plants at Oglesby, Illinois.

The booklet contains more than 70 half tone illustrations explaining step by step the modern method of manufacturing Portland cement from the stripping of the soil down to the final grinding of the clinker. A copy will be sent free upon request to any user of cement.

One of the most interesting features at the plant is the mammoth crusher built by the Power & Mining Machinery Co. of Milwaukee, Wis., of which we give



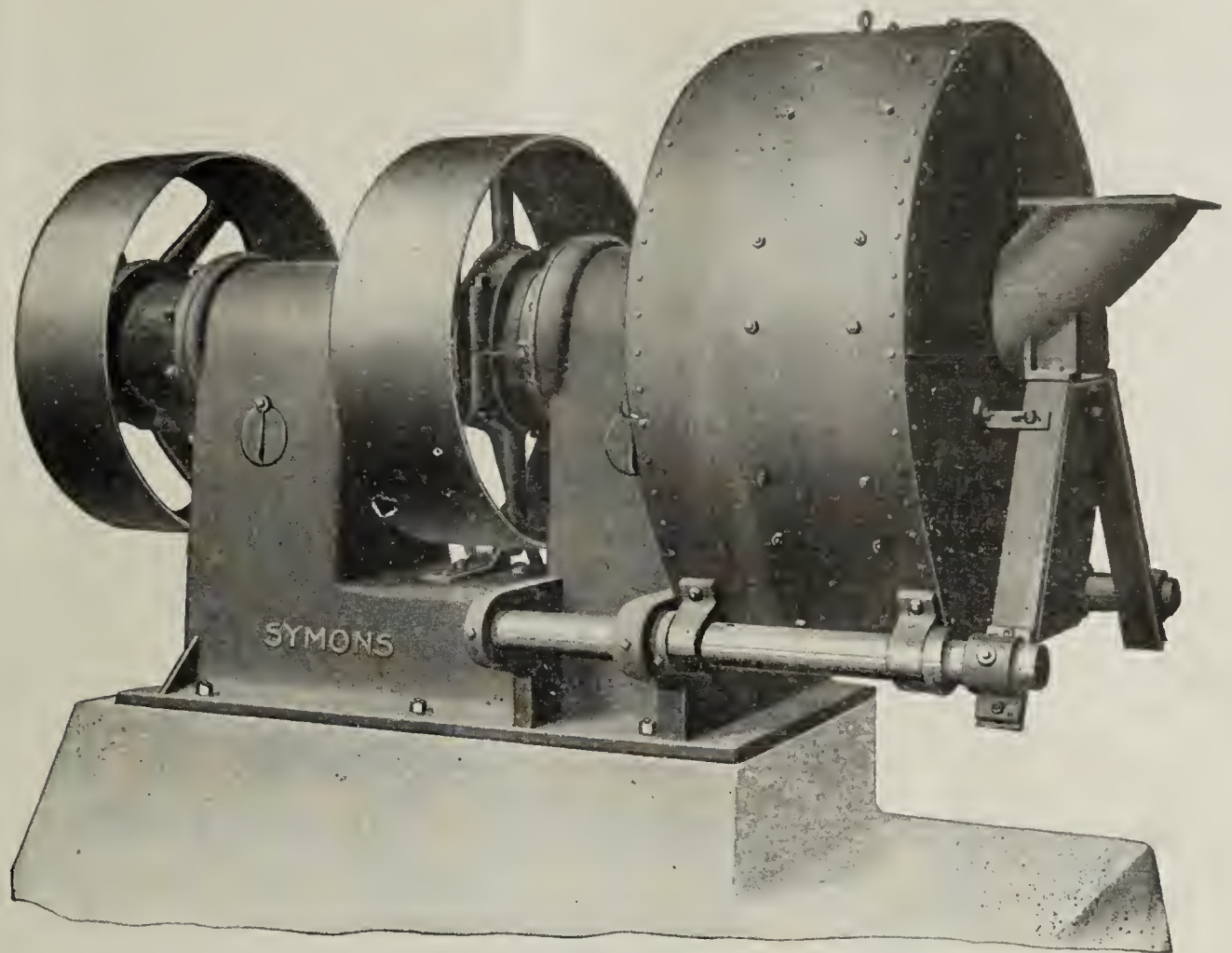
Looking into 210 ton McCully Mammoth Crusher at the Mills of the Chicago Portland Cement Co.

Lime & Cement Co., Kansas City, \$10,000, and 10 cts. The Atlas Portland Cement Co., Chicago, Ill., \$10,240, and 10 cts. P. J. McDonald, Leavenworth, \$13,920. Universal Portland Cement Co., Chicago, \$1.78 per bbl., including sacks valued at 10 cts. each.

an illustration. It represents the largest type of crusher in the world and was installed with a view of obviating all preliminary breaking of the rock after blasting. It is capable of crushing rock 40 inches in diameter and handles the raw material for one and a quarter million barrels of cement per annum.

Here's the Crusher

For Making that
Small
Sized
Product !



THE SYMONS DISC CRUSHER

THE FIRST IMPORTANT QUESTIONS ARE : 1. What will it crush? 2. What capacity per hour? 3. How large is the receiving opening? 4. What horsepower is required? 5. What sizes of product? 6. Shipping weight?

OUR ANSWER: These machines are now crushing trap rock, gravel, boulders, granite, various kinds of ore and limestone in many parts of the United States, in Canada and England, as shown conservatively in the following table:—

TABLE OF WEIGHTS AND CAPACITIES FOR SYMONS DISC CRUSHERS

Size of Crusher.....	48-in.	36-in.	24-in.	18-in.	13-in.
Approx. Shipping Wt.....	30,000	19,000	8,500	5,600	3,000
Opening in Elliptical Feed Spout	11 $\frac{1}{2}$ x 17	9 $\frac{1}{2}$ x 14 $\frac{1}{2}$	7 x 10 $\frac{3}{4}$	4 $\frac{1}{2}$ x 7	4 x 4 $\frac{1}{2}$
Opening between discs at feed spout	8-in.	5-in.	3 $\frac{1}{2}$ -in.	2 $\frac{1}{2}$ -in.	1 $\frac{1}{2}$ -in.
Min. exit opening for best results	1-in.	$\frac{3}{4}$ -in.	$\frac{1}{2}$ -in.	$\frac{3}{8}$ -in.	$\frac{1}{4}$ -in.
	Size of Ring	Size of Ring	Size of Ring	Size of Ring	Size of Ring
	Tons per Hour	Tons per Hour	Tons per Hour	Tons per Hour	Tons per Hour
Cap. in tons per hour.....	1 = 45-60 1 $\frac{1}{2}$ = 60-75 2 = 75-80 2 $\frac{1}{2}$ = 85-100	$\frac{3}{4}$ = 25-30 1 = 30-40 1 $\frac{1}{2}$ = 40-50 2 = 50-60	$\frac{1}{2}$ = 12-15 $\frac{3}{4}$ = 18-20 1 = 20-25 1 $\frac{1}{2}$ = 25-30	$\frac{1}{2}$ = 5-8 $\frac{3}{4}$ = 8-10 1 = 10-12 1 $\frac{1}{2}$ = 12-15	$\frac{1}{4}$ = 4-5 $\frac{1}{2}$ = 5-7 $\frac{3}{4}$ = 6-8 1 = 8-10
R. P. M. Main Pulley	100	133	150	200	300
R. P. M. Eccentric Pulley	200	266	400	450	600
Size of Pulleys	54 x 16	44 x 14	34 x 10	28 x 8	20 x 6
H. P. required	50 - 65	30 - 40	18 - 25	12 - 18	10 - 15

We stand back of these representations in the following manner—
Can you suggest a better way?

—OUR PROPOSITION—

We will ship to any responsible party one of these crushers to be promptly installed and operated, subject to a 20 day trial. If the CUSTOMER is not satisfied in every respect, he may return the machine to our factory without a dollar of payment to us.

Not a risky proposition to us,—for
THE SYMONS DISC CRUSHER MAKES GOOD.

Address **SYMONS BROS. CO.,** 605 Majestic Bldg., Milwaukee, Wis.

RECEIVER IS APPOINTED FOR \$2,500,000 CEMENT COMPANY.

Secretary Ford of People's Portland Cement Company Is Also Enjoined From Selling More Bonds.

Toledo, Ohio, April 5.—The People's Portland Cement Company, capitalized at \$2,500,000, with an unfinished plant at Sandusky, and incorporated under the laws of the state of Washington, with general offices in Chicago, was placed in the hands of a receiver to-day by Judge Killits in the United States Circuit court. Frank L. Cable of Sandusky was named as receiver.

The petition was filed by Charles L. Wagner of Sandusky, a member of the board of directors, and named R. J. Kellogg of Cape Girardeau, Mo., president, and A. S. Ford of Chicago, secretary and treasurer of the company, as co-defendants.

It is charged that the company is insolvent, and that there still remains outstanding indebtedness to the amount of \$110,736.98 for labor, machinery and supplies which the company has no means of meeting. Ford is enjoined from selling any more of the bonds of the company.

MANITOWOC ENGINEERING WORKS.

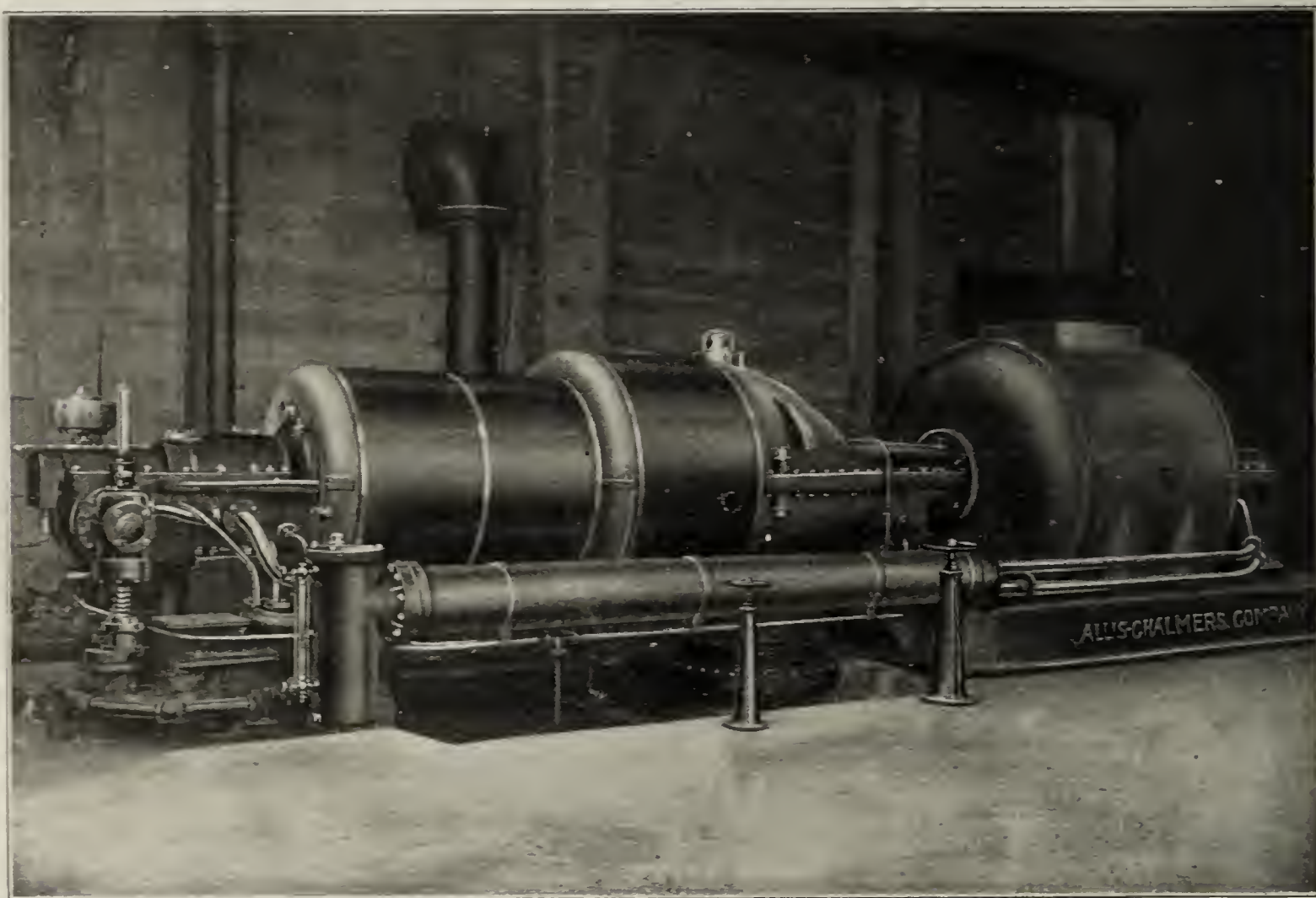
The Manitowoc Engineering Works of Manitowoc, Wis., describe in an illustrated folder, Bulletin No. 106, the design and special features of the rotary kilns and dryers manufactured by them.

Their large boiler works enable them to turn out rotary kilns of the largest dimensions in the shortest time possible. In addition to boilers and cement kilns they are equipped to make coolers, screens, ball mills and tube mills.

ALLIS-CHALMERS STEAM TURBINES.

The accompanying cut illustrates one of the numerous steam turbines installed at cement plants by the Allis-Chalmers Co.

Bulletin No. 1079 of this company describes exclusively the steam turbines and generators built by them and contains cuts of all parts of the machine illustrating fully the working principle and the design of the turbine.



View of Allis-Chalmers Steam Turbine in Helderberg Cement Plant, Howes Cave, N. Y.

CEMENT PRODUCTS.

The General Cement Products Company, Anderson, Ind., has been incorporated to manufacture cement products. Capital, \$25,000. Incorporators, W. J. Wooley, Joseph Zeigler, C. K. Bagot.

* * *

The Fortune Post Company, of Richmond, Ind., has been incorporated with a capital of \$10,000 by M. B. Kelsey, J. E. Peltz and H. B. Williams to manufacture cement posts for fences.

* * *

The Stratman Concrete Co. of Henderson, Ky. was recently incorporated with a capital stock of \$30,000. A. J. Stratman and J. G. Osburn are the incorporators.

ASHLAND FIRE BRICK CO.

A unique way of advertising their fire-brick has been resolved upon by the Ashland Fire Brick Co. of Ashland, Ky.

Every week they send out folders to their customers and prospective buyers of their products giving them in the form of an interesting little chat complete information about their method of quarrying fire-clay and manufacturing fire-brick as well as about the advantages of their products.

All users of fire-brick should write to them and have their names put upon the mailing list of the company. The illustrated talks will do the rest, namely persuade them to give Ashland Fire Brick a fair trial, which many cement manufactureres did heretofore with the result that Ashland fire brick is used at their plants year in and year out.

From the raw crushing department to stock house, all operations in the modern Cement Mill are made more simple and economical by Electric Motor Drive



WESTINGHOUSE motors and power equipment have proven most successful in producing these results in the Portland Cement Plant illustrated.

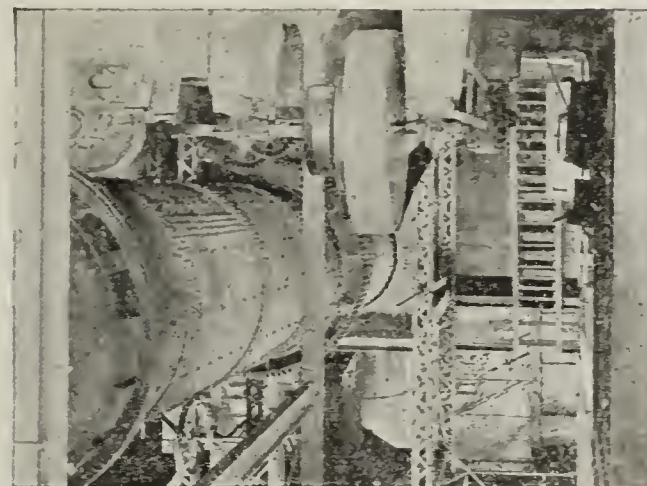
Twenty-seven hundred H. P. of Westinghouse Motors are used for the drive of machinery in all departments, assuring success by the exactness of design to meet the operating conditions. The motors for the heavier types of machines have large starting torque. Dust proof bearings are provided and special care given the mechanical and insulating properties of the coils. Special types of motors, such as the vertical type for the Fuller Mills and slow speed motors for the Tube Mills have been developed and the requirements of every department properly provided for by suitable motor equipment and method of drive.

On request, your Cement Mill propositions will receive a thorough analysis by experienced engineers of the Westinghouse Co. Refer to nearest District office; ask them to send you Section 3073 of Catalogue 3002-A.

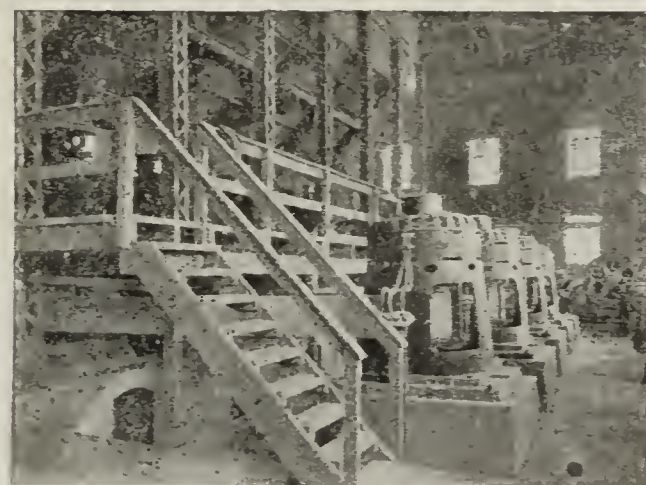
Westinghouse Electric & Mfg. Co.

EAST PITTSBURG, PA.

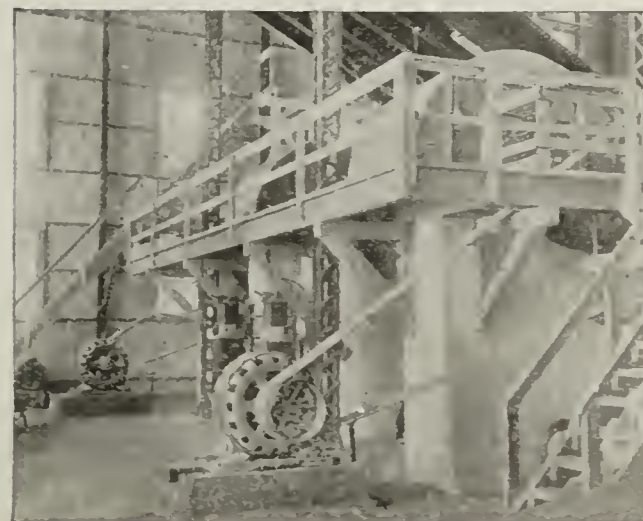
Atlanta	Boston	Chicago	Cleveland	Denver	Kansas City
Baltimore	Buffalo	Cincinnati	Dallas	Detroit	Los Angeles
New Orleans	Philadelphia	St. Louis	Salt Lake City	San Francisco	
New York	Pittsburg			Seattle	
Cuba: Charles H. Thrall & Co., Havana.					
Westinghouse Electric & Mfg. Co., of Texas, Dallas, and El Paso, Texas					
Canada: Canadian Westinghouse Co., Ltd., Hamilton, Ont.					
Mexico: Compania Ingeniera, Importadora y Constratista, S. A.					
(Successors to G. & O. Braniff and Company). City of Mexico.					



50 H. P. Westinghouse Motor Driving Kiln Dryer



75 H. P. Westinghouse Motors Driving Fuller Mills



50 H.-P. Westinghouse Motors Driving Raw Dept. Machinery

CATALOGS RECEIVED.

Friction Clutches and Speed Changers.—The Moore & White Co., Philadelphia, Pa. Catalog; 6x9 in.; 84 pages; illustrated.

The patented friction clutches of this company include a friction disk filled with hard wood blocks; which are drawn in contact on their end grain with the iron surfaces. Descriptions and prices are given of a complete line of clutches, pulleys, couplings, shifters, etc. The speed changer consists of two long cones mounted in a frame, in connection with a screw shifting device. Each cone is provided with a flexible band of taper contact pieces inside a leather belt, and the two are surrounded by a transmission belt which runs as if on two plain high face pulleys, without end thrust or wear.

Metal Building Materials.—Wm. B. Hough Co., Chicago, Ill. Paper; 6x9 in.; 24 pages; illustrated.

The Hunt metal corner beads, described in this catalog, are made in various styles for reinforcing the corners of plaster walls, arches, etc. to withstand wear and tear, and for protecting the corners of reinforced concrete columns, curbs, etc. The Hough special expanded metal lath is also described, together with channel studding, wall plugs and grips, cold twisted reinforcing bars, sheet metal spacers for spacing, supporting and locking reinforcing bars, adjustable anchors for use in concrete construction, etc.

Stucco and Concrete Residences.—Edison Portland Cement Co., New York. Paper; 6x9 in.; 16 pages; illustrated.

The 26 halftone illustrations in this pamphlet are of residences built of the company's product, and show a variety of pleasing designs in stucco, reinforced concrete, combinations of shingle and stucco, stone and stucco, etc.

Concrete Work.—Vulcanite Portland Cement Co., New York and Philadelphia. Pamphlet No. 11. 6x9 in.; 112 pages; illustrated.

This is a short treatise on the various uses to which concrete may be put on the farm. Clear directions are given for mixing and proportioning concrete and for making forms, for the thousand and one constructions which are possible with the material, and which conduce to sanitary conditions and convenience. Among these constructions are floors, foundations, tanks, cisterns, mangers, fence posts, rollers, walks, drives, manure pits, etc. A nominal charge of 25 cents is made for each copy.

NEW CEMENT MILLS.

Work on the construction of a large cement plant at Princeton, B. C., will start about May 15th.

A. R. Campbell, surveyor and engineer, has received the ground plans of the proposed cement plant of the Olympic Portland Cement Company at Bellingham, Wash. This plant is being built for the Balfour-Guthrie Corporation of Seattle. Mr. Campbell is now running the lines and locating various buildings to be constructed.

A trip made by a party of strangers to a point about six miles north of Jeffersonville, Ind., has started a rumor that the question of establishing a Portland ce-

ment mill at Belknaps is being considered. The visitors remained in the vicinity of Belknaps for some time looking over the ground and taking samples of rock at the point where the Black Diamond cement mill was formerly located. It is supposed that the Lehigh Cement Company, which has a Portland cement plant at Mitchell, is to back the new enterprise.

Work will begin on the new cement plant to be erected at Oswego, Oregon, which is to cost \$500,000. Robert A. Klassen can give names of parties interested.

The Royal-American Portland Cement Company of Rapid City, S. D., which has been incorporated with a capital stock of \$3,500,000, has secured 1,120 acres of land on which it will erect a plant to have a daily capacity of 5,000 barrels of cement. Frank L. Ackerman of Rapid City is president and C. C. Crabtree of Rapid City is secretary and treasurer.

G. S. Gilbertson of Des Moines, Ia., has been chosen president, and W. J. Souder, also of Des Moines, has been appointed superintendent of the Dakota Portland Cement Company which is erecting a plant at Chamberlain, S. D.

H. H. Lansing of Fayetteville, N. Y., and Calvin McCarthy of Jamesville, N. Y., are interested in properties in the vicinity of Fayetteville which contain gypsum. A company with a capital of \$100,000 will be incorporated to develop the industry.

A million dollar corporation, the Bald Mountain Portland Cement Company of Rome, Ga., has applied for a charter. The incorporators are J. C. Bass, W. J. Griffin and G. T. Haynes, of Rome; M. M. Luck of Dalton and S. W. Palmer of Millen. A cement plant will be erected about a mile from Aragon, on the proposed line of the Tennessee, Alabama & Georgia Railway. The deposits of shale and limestone are practically inexhaustible. There is enough to manufacture 2,000 barrels of cement per day for 600 years.

W. J. Miles of Gettysburg, S. D., has secured the contract for the Hot Springs Gypsum company's new plant at Hot Springs, South Dakota.

The Associated Portland Cement Company of London, England, of which H. K. Bamber is managing director, is securing sites for the establishment of several cement plants in Canada.

The Portland Cement Corporation has been incorporated at Tulsa, Okla., with a capital stock of \$300,000. A new plant will be built under the supervision of L. F. Barnes. The following are the directors: L. F. Barnes, J. W. McCloud, J. T. Crosbie, J. O. Mitchell, Chas. Hounker, H. R. Crews, C. F. Tingley and O. H. Leonard, all of Tulsa.

Engineers F. L. Smidth & Co., 50 Church St., New York, N. Y., have completed plans for the construction of the \$1,000,000 cement plant at Bellingham, Wash., for the Balfour-Guthrie Co., Seattle, Wash. The engineers will have charge of awarding all contracts. The plant will have a daily capacity of 1,600 barrels.

The Canada Cement Company will establish a plant at Winnipeg as soon as possible, to have a capacity of 400,000 barrels per annum.

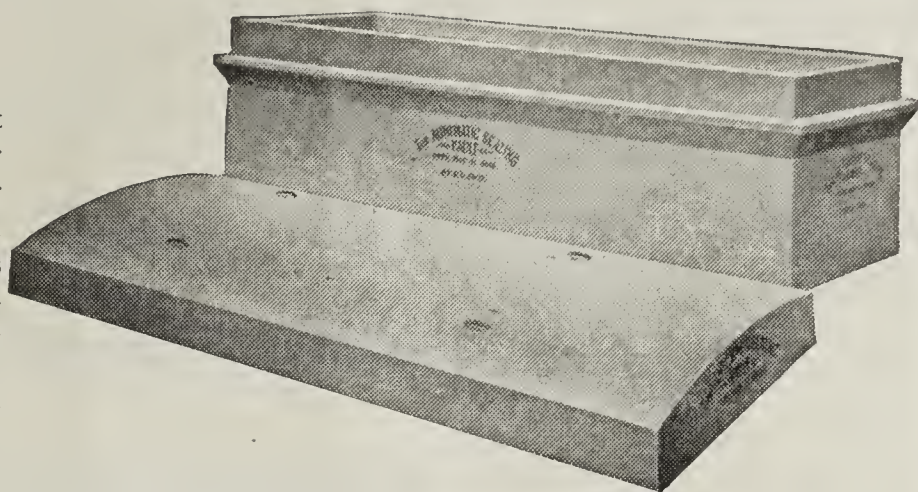
A Plain Talk to Concrete Men

About a Profitable Business

Concrete Burial Vaults.

Mr. Concrete Contractor:—Don't be prejudiced—don't think that the vault business means peddling vaults for funerals. You can manufacture concrete vaults in your plant and sell them to the undertaker, just as you sell blocks to a contractor. You can manufacture vaults as an independent business, selling your output to the undertaker, or you can run the business as a sideline to your present plant, keeping your force busy in dull season.

Concrete burial vaults are without competition. They are in demand. They sell at a good price. You make three times the profit on them that you do on other products.

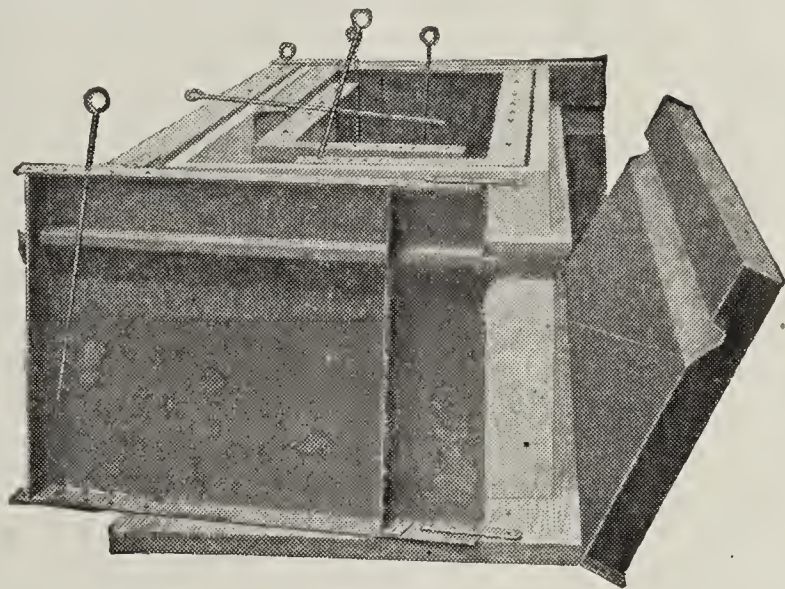


Automatic Sealing Vault. Note the pleasing proportions and beauty of design.

The Automatic Sealing Vault.

Our vault was invented by a practical undertaker. It is medium weight, steel-reinforced, waterproof, ghoul-proof, sanitary. It is made in two pieces. The lid is sealed automatically in the grave. No other vault can compete with it.

Our Bessemer steel mold is adjustable. Seven sizes of vaults are made on one mold. The molding surfaces are without rivets or other unevenness, casting a smooth, clean vault. You don't have to buy a big equipment—this one mold does it all. You can make a complete vault every day.



Removing adjustable mold from completed vault in 12 hours. Note the clean-cut outline.

Profitable Investment.

You can readily see from the amount of material which is required to build our Automatic Sealing Vault, that there is no other line of cement work that affords the large profit which is derived from vault manufacturing.

It takes 6 cubic feet of cement.

12 cubic feet of sand.

15 lbs. reinforcing material.

3 lbs. of water-proofing.

8 hours labor to make a standard size vault.

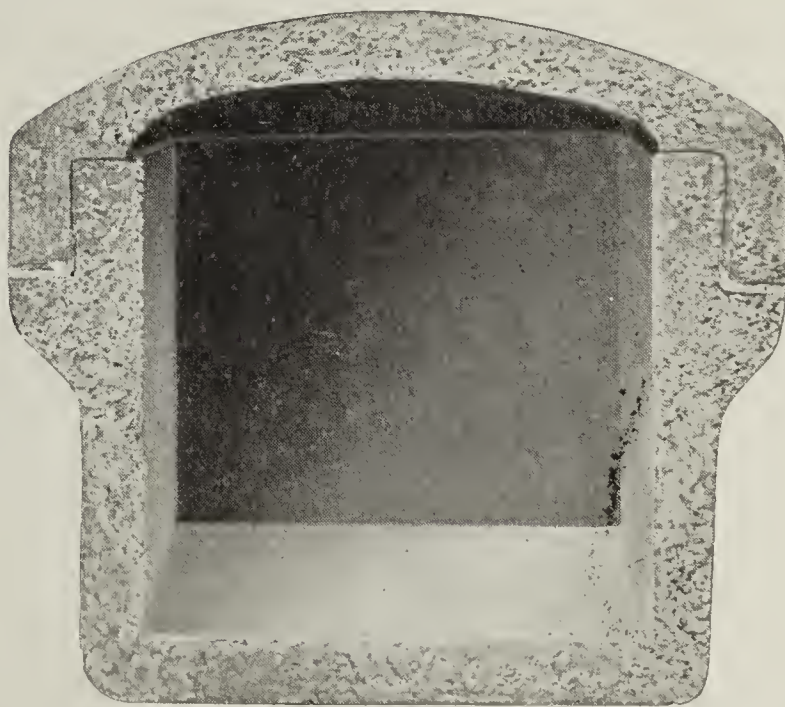
Total cost of above \$5.70.

The manufacturer gets from \$25.00 to \$30.00 and the undertaker retails them from \$40.00 to \$50.00.

Our big book tells all about it. Write us today.

FREE BOOK ABOUT VAULT MANUFACTURE.

This book tells about the vault, the mold, the reinforcement, how to make vaults; the exact cost of manufacture; the sales price; how to sell vaults, etc. Ask for a copy, mentioning this advertisement in Cement and Engineering News.



Cross-section of vault, showing method of placing lid onto the vault that makes it absolutely waterproof on account of the air pressure.

The Automatic Sealing Vault Co.
PERU, INDIANA

CEMENT MILL NEWS.

Estimates for a cement plant to cost \$750,000 that will provide a mill with a 2,000 barrel capacity, are being prepared by J. T. Klossoski, Dixon, Ill., and R. D. Hassan, experts, employed by the million dollar Edmonton (Canada) syndicate that will develop the marl beds near Edson on the Grand Trunk Pacific.

The Gilmore City Construction Co., Gilmore City, Iowa, is building a cement plant at that city for the Fort Dodge Portland Cement Corporation, Fort Dodge, Ia., the plant having been designed by Engineer C. McLaughlin, 322 Midland Bldg., Kansas City, Mo. The mill will have a daily capacity of 5,000 barrels of "Fort Dodge" cement. The dry process of cement manufacture will be employed, the equipment including ten kilns 8'x125'. Coal will be used for fuel. The company is capitalized for \$3,500,000. The officers are: F. D. Brandenburg, president; H. S. Van Alstine, secretary and treasurer; T. A. Mair, general manager.

The Phoenix Cement Co., Nazareth, Pa., is about to arrange extensive improvements at its mill, enlarging the roasters and building a crushing and grinding department, so that it will have a capacity of 600 barrels a day.

Bondholders, mostly Philadelphia investors in the Whitehall Portland Cement Company have applied for a new charter and intend to set the plant going at an expense of \$400,000. This will be expended principally for new, up-to-date machinery.

The Hecla Cement plant at Bay City, Mich., will close down in a few days, after a nine months run, to await the return of normal market conditions. It was stated by Superintendent Arthur G. Beck that contemplated improvements involving a change in the process of manufacture, and costing about \$250,000 will be made before operations are resumed, but the work will await the adjustment of a big rate reduction fight, now on.

The new cement plant at La Tolteca, state of Hidalgo, Mexico, is now completed and is turning out 100 tons of Portland cement daily, with capacity, when their plans are fully completed, of 400 tons.

This company possesses enormous deposits of clay and limestone which are remarkably uniform throughout. The raw materials are first ground to reasonable fineness and then accurately weighed on hopper scales in the mixing department. Chemical analyses and tests follow the material at each step throughout the entire process until the finished ground cement is in the bags ready for shipment. All raw materials are dried before they enter the mixing department in continuously revolving steel tubular driers to the end that all weights are accurately adjusted on a uniform dry basis independent of the rainy season or the dry season. Both the raw material before burned and the finished cement is ground in the largest sized tube and ball mills that have ever been installed in Mexico. Some of these mills contain 12,000 pounds of steel balls, while others contain similar large amounts of flint pebbles from Norway. The various machines and kilns are electrically actuated by means of individual motors, which enables the operator to increase or decrease the speed of the mill as well as the temperature of kiln and time which cement will be in passing through the "Hot Zone." The revolving kiln proper is a steel tube 8 feet in diameter and 135 feet long, which weighs, with its fire brick lining and cement

load, approximately 500,000 pounds. Imported coal of suitable quality is used in the kiln, which coal is first ground to an impalpable powder and which when burned in the kiln produces a flame from 35 to 40 feet in length.

A separate building is devoted to testing of cement and materials. This building contains both physical and chemical testing laboratories which are completely equipped with modern testing instruments and machines. Tests of the raw material and of the finished cement are made regularly at intervals of one hour so that accurate knowledge is afforded and maintained covering each step of the manufacturing process. The factory is provided with a large cement stockhouse where 50,000 barrels of cement can be stored. This stockhouse is arranged with series of bins for bulk cement and for storage of sacked cement, and is provided with two railway sidings, one on each side of the long house, with doors so arranged at distances of car lengths that a dozen cars may be loading at the same time.

The Tolteca Portland Cement Company is capitalized at \$1,000,000 (gold). F. S. Larabee of Kansas is president. The management is in the hands of W. E. Burk, Ch. E., vice-president and general manager, while the superintendency of the factory at Tolteca is in charge of H. W. Palmer, E. E., who before coming to Mexico was superintendent of cement manufacturing works in the United States.

Indications are that the production of Portland cement in the United States for the year 1911 will equal if not exceed most of the estimates which have been made by optimistic believers in the business. From statistics and estimates received by the United States Geological Survey from about 20 per cent of the companies manufacturing Portland cement, representing nearly half of the entire output of the country, it is estimated by E. F. Burchard, of the Survey, that the quantity of Portland cement manufactured in the United States in 1910 was between 73,500,000 and 75,000,000 barrels, as compared with 63,508,471 barrels produced in 1909—an increase of 500,000 barrels, or 15 to 20 per cent. The figures at hand are derived from all parts of the United States, and are therefore considered to be representative of the country at large rather than of any single section or district.

Although the average values for 1910 appear, from returns received thus far, says the preliminary report of the Survey, to have been slightly higher than in 1909, prices were far from satisfactory, especially to the large manufacturers in the Lehigh Valley district and in certain of the Eastern States. The year 1911 opens with prices cut 5 to 10 cents a barrel lower than those prevailing in 1910. The construction of several new plants has been pushed during the year, and several plants that were under construction in 1909 became producers in 1910, so that the kiln capacity remains far in advance of the demand.

The Portland cement mill at Speeds, Ind., which has been idle for a time making repairs, will resume operation again, giving employment to 300 men.

The Superior Portland Cement Company, which has a large plant at Concrete, Wash., has decided to build another kiln, which will increase the output, approximately one-third. When the new kiln is installed the capacity of the plant will be 2,000 barrels of cement per day. N. L. Warford is superintendent of the mill.

CEMENT
... AND ...
ENGINEERING NEWS



Dr. Wilhelm Michaelis, Sr. †

CEMENT AND ENGINEERING NEWS

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Advertising Manager

Chicago, June 1911.

DR. W. MICHAELIS SR.

Upon the fourteenth of May suddenly ended, in consequence of an internal hemorrhage, the active life of the foremost cement expert of the present day Dr. W. Michaelis Sr. of Berlin, Germany.

The great name and the teachings of this ardent worker in the field of cement research are known all over the World to every one who made even a superficial survey of the cement literature. The subscribers to this magazine, however, have been more fortunate than others, who read only brief abstracts of his papers, in as much as we were able to publish complete translations of his essays of recent years which explained the hardening process of hydraulic cements in an entirely novel way, in a manner which caused the severest criticism in the beginning, but which found the ultimate approval of all scientists who took the pains to explore the subject thoroughly.

In these days of grief, when not only the engineering world of his native land, but of all civilized nations taking a part in the development of great engineering problems, mourn the loss of their noblest representative, it behoves to review the brilliant and utterly unselfish career of a man who, for about 50 years, lavishly gave to his fatherland and to the World at large hard-earned information and who, for many decades, received in return nothing but opposition and unwarranted attacks from many quarters. Like many great scientists and inventors he was, in all his thoughts and researches, a generation ahead of his time, and consequently had invariably to wait a long time for recognition of his teachings. None of the important revelations made public during the various stages of his research work was accepted at once. In most instances, twenty or thirty years elapsed before the engineering world tested and universally acknowledged his theories. But, unlike numerous others upon whom Fortune bestowed a similar fate, Michaelis was at least lucky enough to live long enough and to see the day when even his greatest opponents acknowledged his views to be true and turned into admirers and when, about a year ago, shortly before having completed his seventieth year, the German Emperor conferred the title of an honorary professor upon him as a public recognition of the benefit the country derived from his research work.

The position which Michaelis occupied in the engineering profession was unique. Most others who achieved similar results had the wealth of universities or associations behind them or at least the moral support of a multitude of fellow workers interested in the

outcome of the work. Michaelis had to fight his battles single-handed and had himself to provide the means for his expensive researches which, in time, consumed a fortune. The only endowment he brought with him into this life was robust health and the ability to work hard for a living which he was called upon to test at an early age.

His university studies in engineering and chemistry ended with a thesis on Portland cement, a product being manufactured at that time in Germany at about half a dozen factories recently erected in imitation of English plants. This university laboratory work promptly secured for him admission to cement factories which were in need of men equipped for a thorough study of the mysterious new material which was produced in a haphazard way. After he had worked at several cement plants for a number of years, he decided to establish a private laboratory for cement research and thus abandoned his previous intention of becoming a university professor. Outside of his professional work, he carried on researches and, first of all, compared the composition of the various brands of German and foreign cements which had given good service with the view to establishing rules for the chemical composition of cements.

Several years of research in this direction led to the publication of his book on “Hydraulic Mortars”, published in 1869. This work received the highest appreciation among all technical men engaged in the new industry and, at once, founded the reputation of the young cement expert. It comprised a complete review of all previous researches on cement materials and a detailed description of the machinery employed in the manufacture of cement; it offered a comprehensive research covering the composition of all existing brands of Portland cement of importance and contained, as a deduction, rules for calculating the composition of cements which are closely adhered to up to the present time. This first great contribution by Michaelis to the cement literature forms most interesting reading even in our present days of modern cement machinery. The methods of burning and grinding cements have been changed and improved, but the relative chemical composition of the various ingredients contained in Portland cement was established by him for all times and little, in this respect, had to be added in the future. It is astonishing how much information this book imparted at this early stage of development of the European cement industry.

As a consequence of this first proof of his thorough acquaintance with cement materials, Michaelis was called upon to design and superintend a number of cement plants in Germany as well as in various other European countries. The engineering work which amply filled his time had to be accompanied continuously by laboratory control and by research work undertaken with the intention of keeping abreast with the times and of steadily improving the process of manufacture and the methods of testing cement and of establishing its value.

Machinery had to be devised for determining in a quick and reliable manner the tensile strength of the cements as well as a number of other physical properties. Continuous tests, extended over periods of 5, 10, 20 and 30 years, established in time the influence of salt solutions upon various kinds of cement and thus gave birth to Michaelis' publications on the behavior of cements in sea-water. At an early date, he recognized the importance of an admixture of puzzuolana to Portland cement for the purpose of protecting the decomposing cement by combining the lime liberated during the process of hydration with the silica of the puzzuolana. These and a great number of other important

points were discussed by him in altogether more than a hundred essays which form a voluminous literature.

His efforts in establishing standard rules for the valuation of cements and his contributions along these lines soon made Michaelis one of the principal speakers at the meetings of cement manufacturers and at the same time unfortunately also the target of the attacks of all dissatisfied people who would not accept his explanations, though based on careful scientific research, merely because they interfered at times with their financial interests, for instance compelled the manufacturer to grind cement more finely or excluded certain brands of cement from the market, or gave the owners of natural puzzuolana deposits or manufacturers of artificial puzzuolana a chance to sell their products and to replace a certain percentage of the cement by puzzuolana.

Together with his friends Bauschinger and Tetmayer, who superintended mechanical testing stations at the universities of Muenchen and Zuerich, he brought about the numerous conventions of engineers which, after years, led to the formation of the International Society for Testing Materials.

As his chemical investigations had convinced him that lime and silica were the principal factors in the hardening process of cements, and alumina only an accessory and superfluous, in many respects even detrimental, ingredient of hydraulic cements, he bent his efforts on producing cements without alumina. The fruit of many years of hard work in this direction were his patents on sand-lime products and on iron-ore cement, the former a combination of quartz-sand and lime, which necessitated the application of high-pressure steam, and the latter a Portland cement free of alumina and, therefore absolutely safe in sea-water and salt solutions containing sulphates.

These patents have placed, and will place in the future, millions in the pockets of manufacturers. Michaelis worked out the process under the greatest difficulties, patiently waited for the time when people would take an interest in his inventions and saw his patents expire by the time capitalists took a hold of them. To-day one thousand million sand-lime brick are manufactured annually alone in the neighborhood of Berlin, and the capital invested in this industry amounts to hundreds of millions. The inventor spent all the money he could on the development of his processes, but never received a cent in return.

The history of the development of sand-lime products and the obstacles that had to be overcome were described in an interesting manner in one of Michaelis' latest publications on "The Hardening Process of Hydraulic Cements" (published in Cement & Engineering News in 1907.)

These essays explaining the hardening of cements in an entirely different way from all previous experimenters will belong to the classical cement literature for all times to come. They attributed the hardening, and especially the resistance of the mortars to water, to the gradual drying out of colloidal bodies, which were deprived of their colloid water by the hitherto undecomposed core of the cement grain which gradually absorbed it and hydrated in time, thus increasing the density of the mortar and adding to its imperviousness.

These revelations, which were intimated but not sufficiently explained, fifteen years before the publication of the final papers, made the same impression on the cement world as a thunderbolt from a blue sky or as Copernicus' announcement upon the Clergy of the Middle Ages to the effect that the Earth was a globe revolving around the Sun. Cement chemists had believed exclusively in a process of crystallisation up to

that time and could not understand the boldness of a human being of attributing the hardening process of cements to something else. All subsequent researches, however, fully explained the mistakes previous investigators made. In examining cement particles under the microscope, they used many times more water than employed in the making of mortars; they, thus, decomposed the grains of cement completely and could easily cultivate all kinds of crystals in over-saturated solutions. But, as soon as the water was reduced to the small amount used in the manufacture of cement briquettes or mortars or concrete, formation of crystals disappeared almost entirely and colloids were observed exclusively in their various stages of water absorption, that is to say forming a thin transparent jelly in the beginning and drying out and becoming denser, harder and less transparent in time by gradual absorption of the water.

Michaelis' own researches compelled him, of course, to read, to investigate and to discuss with other experimenters everything going on in this line of work all over the World. He corresponded and argued his points at public meetings in three languages, German, French and English, and had friends all over the Globe. His daily mail contained as many letters from the Orient or from America as from Europe. He induced many of his friends to join the International Society for Testing Materials and was an able interpreter at the conventions at which it was, at times, his task to make the representatives of a dozen nations agree on a point at issue.

His cosmopolitan views excluded all thoughts of egotism or rivalry among nations. Whoever could advance a grain of thought towards furthering the scientific research of cement was his friend, no matter to what nation he belonged. Therefore, he took as much delight in the reading of foreign literature as in that of his own country and kept close watch on everything reported in foreign magazines. From personal correspondence and from a publication in a German technical magazine we know that the last important essay on cement research he read, enjoyed and favorably commented upon, was the latest publication of the scientists of the Carnegie Institution, Messrs Shepherd, Rankine & Wright.

His eyes are closed forever, his pen will no longer reveal new thoughts, and yet his spirit will be in our midst for a long time to come, as it will take all of us the rest of our days to digest, to re-examine and to utilize the immense amount of information he has so liberally bestowed upon the engineering world.

SAND-LIME PRODUCTS.

By E. Leduc & Ch. de la Roche.

(Continued from page 172.)

Chemical and Physical Properties of the Lime.

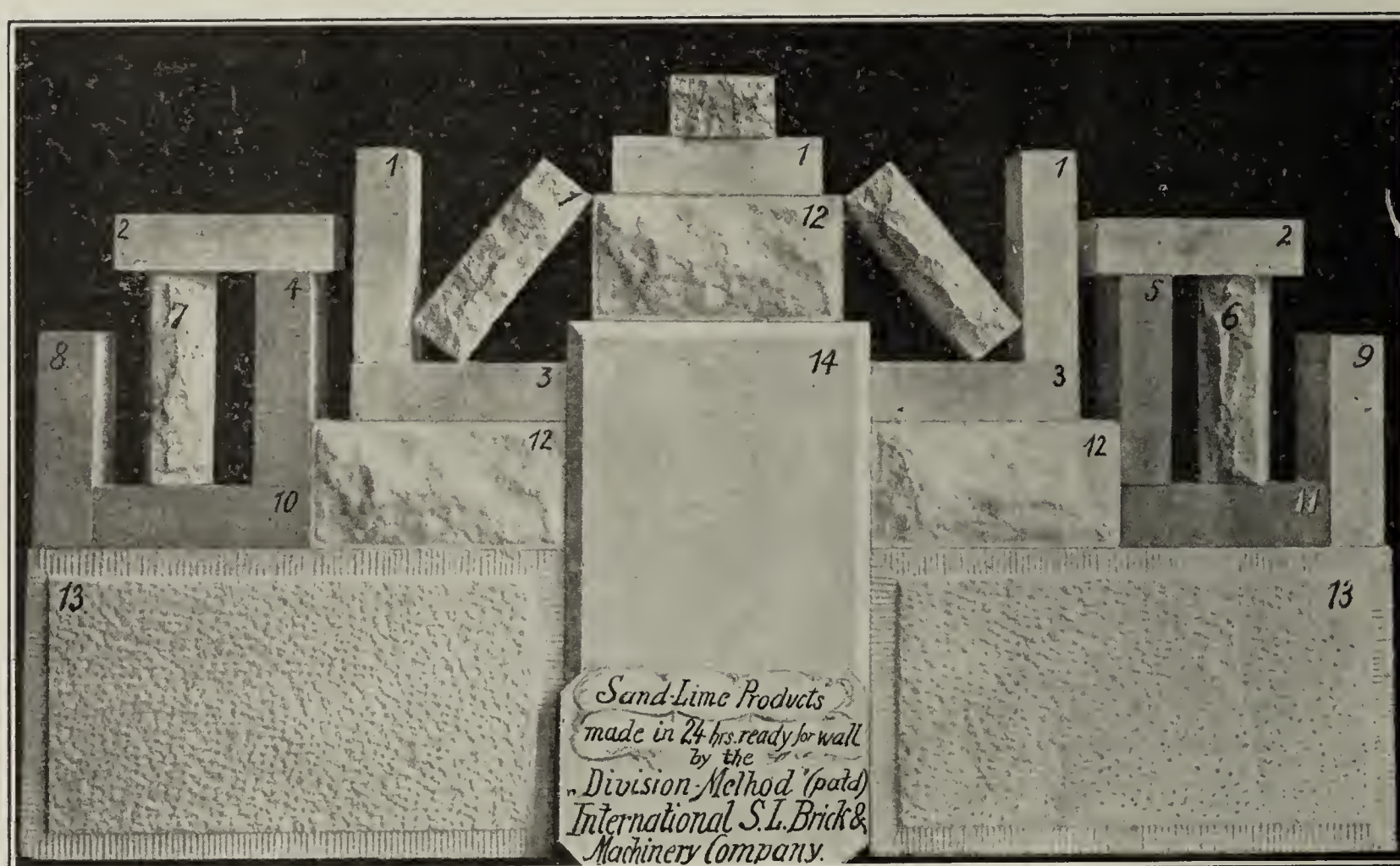
Effect of Varying Amounts of Lime: Through the experiments recorded in table XI we endeavored to show the result of increasing percentages of hydrated lime. These tests plainly demonstrate that the strength of the hardened products decreases beyond a certain proportion of lime (30% in our tests). This limit will vary, of course, according to the nature of the sand and lime used.

Table XII contains likewise the results of test pieces made with steadily increasing amounts of lime. However, in this case, the difference in the percentage of lime between two sets of tests is only 1% of hydrated

TABLE XI.

Amount Of Lime Varying 10% Between Two Mixtures.

Hydrated Lime in percent	Sand in percent	Initial Compression of Mixture lbs	Steam Pressure lbs	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs per sq. in.				Average
10	90	3,750	150	6	2,040	2,085	1,860	—	1,995
20	80	"	"	"	2,895	2,445	2,310	—	2,550
30	70	"	"	"	2,550	2,632	2,738	—	2,640
40	60	"	"	"	2,220	2,437	2,175	—	2,277
50	50	"	"	"	1,463	1,815	2,093	—	1,790
60	40	"	"	"	1,703	1,853	1,725	—	1,760
10	90	"	120	6	2,137	1,763	2,100	2,025	2,006
30	70	"	"	"	2,325	2,325	2,250	2,325	2,308



lime, while it amounted to 10% in the former table. The highest percentage of lime employed in these tests is 15%, which may sometimes be used in the manufacture of sand-lime products, though 10% are not surpassed as a rule.

These latter experiments show that, up to 15%, the strength is directly proportional to the amount of hydrated lime used. They demonstrate, furthermore, that an increase of the initial pressure, put upon the brick or block in moulding it, enables the manufacturer to reduce the amount of lime in the sand-lime mixture, as the set of tests marked 1080 with only 6% of lime gave the same result as 1092 with 8% of lime. The former series of test cylinders was compressed at 7500 lbs., while the latter was subjected only to a pressure of 3750 lbs. The other test pieces of the same table show similar results; for instance, No. 1081 with only 7% of lime had the same strength as 1096 with 12% of lime. Also here the pressure employed in moulding the blocks was 7500 lbs. in the first instance and 3750 lbs. in the latter.

Moreover, increased pressure in moulding has a marked influence upon the resistance of the block to freezing. While tests No. 1094 with 10% of lime did not pass the freezing test, No. 1080 with only 6% of lime, but moulded with twice the pressure of the former, withstood the test perfectly.

Results of the Application of Hydraulic Lime: Local conditions may make it imperative sometimes to use hydraulic lime instead of fat lime, which latter is often much more expensive.

Table XIII shows that the strength of sand-lime mixtures made with hydraulic lime grows steadily with increasing amounts of lime, whereas the experiments carried on with fat lime (table XI) taught that the strength decreased beyond 30 % of lime. This, of course, is easily explained, as sand-lime products made with hydraulic lime are really compressed mortars of sand and hydraulic lime, the strength of which is invariably in proportion to the percentage of cement (hydraulic lime) used.

As the chemical composition and the properties of various grades of hydraulic lime differ, we compared

(table XIV) two kinds of hydraulic lime with pure lime (fat lime) and Portland cement.

A comparison of the results shows that pure lime yields higher results than hydraulic lime or Portland cement as long as the low percentage of lime, customary in the manufacture of sand-lime products, is not exceeded. On the other hand, if this proportion is sur-

high grade of Portland cement gives inferior strength to a similar product made with pure lime. This, however, can not be otherwise, as a simple reflection shows that the sand grains can be cemented together only upon being acted upon by the hydrated lime. In the case of a mixture containing 10% of hydrated lime, which represents a very voluminous powder, the 90 %

TABLE XII.
Amount of Lime Varying 1% Between Two Mixtures.

No.	Hydrated Lime in percent	Sand in percent	Initial Compression of mixture in lbs	Steam Pressure in lbs	Time of Exposure to Steam in hours	Resistance to Compression after hardening in lbs per sq. in.				Average
1.090	6	94	3.750	120	6	1.613	1.388	1.463	1.500	1.490
1.091	7	93	"	"	"	1.463	1.575	1.538	1.650	1.555
1.092	8	92	"	"	"	1.763	1.725	1.688	1.688	1.716
1.093	9	91	"	"	"	1.800	1.725	1.725	—	1.750
1.094	10	90	"	"	"	1.800	1.800	—	—	1.800
1.095	11	89	"	"	"	1.725	1.875	1.875	1.875	1.837
1.096	12	88	"	"	"	1.875	1.950	1.875	1.800	1.875
1.097	13	87	"	"	"	1.875	1.950	1.912	1.988	1.931
1.098	14	86	"	"	"	2.025	2.100	1.987	2.100	2.053
1.099	15	85	"	"	"	2.138	2.062	2.062	1.988	2.063
1.080	6	94	7.500	"	"	1.725	1.687	1.725	1.763	1.725
1.081	7	93	"	"	"	1.837	1.875	1.950	1.883	1.886
1.082	8	92	"	"	"	2.100	2.025	2.062	2.175	2.090
1.083	9	91	"	"	"	2.175	2.138	2.213	2.175	2.175
1.084	10	90	"	"	"	2.363	2.288	2.288	2.325	2.316
1.085	11	89	"	"	"	2.400	2.400	—	—	2.400
1.086	12	88	"	"	"	2.438	2.400	2.438	2.475	2.438
1.087	13	87	"	"	"	2.550	2.512	2.662	2.512	2.559
1.088	14	86	"	"	"	2.550	2.588	2.588	2.512	2.560
1.089	15	85	"	"	"	2.550	2.550	2.588	2.588	2.569

Freezing Tests.

1.090	.....	Begins to disintegrate after being frozen 12 times and falls to pieces after 15 times.
1.091	.....	Partly disintegrated.
1.092	.....	Beginning of disintegration after having been frozen 3 times.
1.093	.....	Upper edge slightly worn.
1.094	.....	Slight fissures after having been frozen 12 times.
1.095	.....	Edges very slightly worn.
1.096	.....	Upper edge partly indented.
1.097	.....	In perfect condition.
1.098	.....	" " "
1.099	.....	" " "
1.080	.....	Upper edge slightly indented and partly worn.
1.081	.....	Upper edge worn very slightly.
1.082	.....	In perfect condition.
1.083	.....	" " "
1.084	.....	" " "
1.085	.....	" " "
1.086	.....	" " "
1.087	.....	" " "
1.088	.....	" " "
1.089	.....	" " "

passed, hydraulic lime and Portland cement give higher strength than sand mixtures with pure lime, which is perfectly natural. In the case of Portland cement, the mixture is nothing but a real hydraulic mortar which has, in every instance, the higher a resistance the more cement it contains.

It may appear unusual that a product containing a

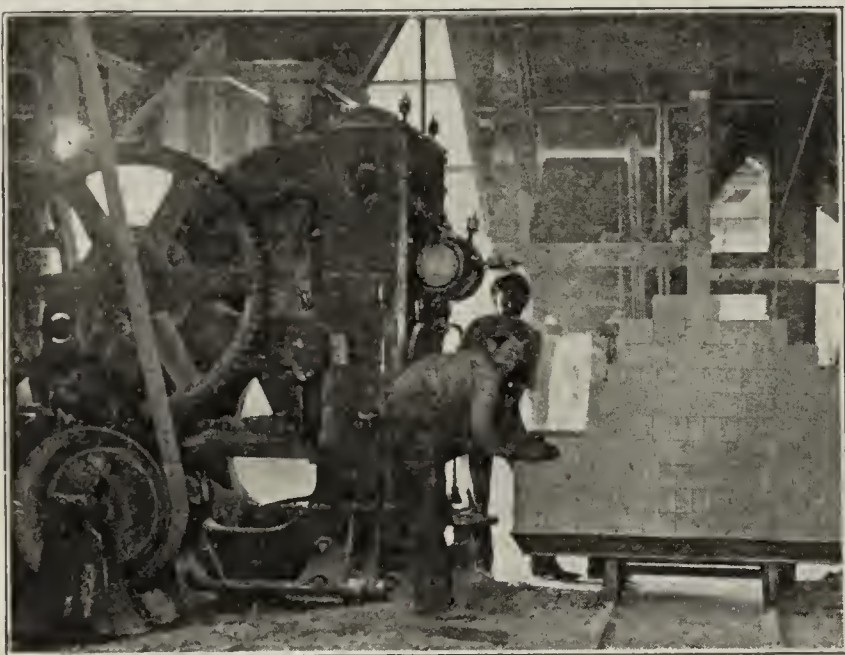
of sand grains are completely enveloped by the lime, whereas an equal weight of Portland cement, which occupies only one-third of the volume of hydrated lime, is insufficient to coat the sand grains as thoroughly. But, if the percentage of pure lime, hydraulic lime and Portland cement are raised, table XIV plainly illustrates that the latter two cements give results far

superior to hardened mixtures made with pure lime. Thus, the test pieces with 30 % of Portland cement yielded 5370 lbs., whereas the blocks of the same proportion of pure lime had only a strength of 3522 lbs.

In order to throw additional light upon this question, we prepared another series of tests, in which we compared five brands of hydraulic lime of different origin one with another and with pure lime. With each brand

TABLE XIII.
Results Of Varying Amounts Of Hydraulic Lime.

Nature of Lime	Hydraulic Lime per-cent	Sand percent	Initial Compression of Mixture lbs	Steam Pressure in lbs	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs per sq. in.				Average
Hydraulic Lime	10	90	3,750	150	6	750	788	750	750	760
	20	80	"	"	"	1,260	1,950	1,163	1,200	1,393
	30	70	"	"	"	3,000	3,038	3,000	2,888	2,981
	40	60	"	"	"	3,525	3,225	3,487	3,488	3,431
	50	50	"	"	"	4,860	4,860	5,175	5,655	5,137
	60	40	"	"	"	4,950	5,910	5,175	5,400	5,359



Interior of a Sand-Lime Brick Plant at Melbourne, Australia, built by the International Sand-Lime Brick and Machinery Co. of New York.



Conveying Sand at the Silica Brick Plant at Melbourne, Australia.

TABLE XIV.
Comparison Between Pure Lime, Hydraulic Lime And Portland Cement.

Nature of Cement	Pure Lime or Hydraulic Lime or Portland Cement percent	Sand percent	Initial compression of mixture lbs	Steam Pressure in lbs	Time of Exposure to Steam hours	Resistance to Compression after hardening given in lbs per sq. in.				Average
Pure Lime	10	90	7,500	120	6	2,813	2,670	2,813	2,670	2,742
	20	80	"	"	"	3,300	3,300	2,363	2,363	2,832
	30	70	"	"	"	3,563	3,563	3,600	3,360	3,522
Hydraulic Lime A.	10	90	"	"	"	1,734	1,781	1,875	1,688	1,770
	20	80	"	"	"	3,000	3,600	3,000	3,000	3,150
	30	70	"	"	"	4,313	4,313	4,077	4,077	4,195
Hydraulic Lime B.	10	90	"	"	"	1,265	1,265	1,103	1,265	1,225
	20	80	"	"	"	1,970	1,992	1,875	2,155	1,998
	30	70	"	"	"	2,155	2,068	2,250	2,250	2,180
Portland Cement	10	90	"	"	"	1,966	2,190	2,068	1,992	2,054
	20	80	"	"	"	4,077	3,941	3,888	3,600	3,876
	30	70	"	"	"	5,340	5,550	5,250	5,340	5,370

TABLE XV. A.

Pure Lime Compared With Different Brands Of Hydraulic Lime.

No.	Nature of Lime	Pure Lime or Hydraulic Lime perc.	Sand per cent	Initial Compression of Mixture lbs	Steam Pressure lbs	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs per sq. in				Average
1117	Pure L.	8	92	3.750	120	8	1.883	1.725	1.950	1.912	1.868
1118	2.587	"	"	"	"	"	563	563	600	563	572
1119	2.588	"	"	"	"	"	600	638	600	600	610
1120	2.602	"	"	"	"	"	1.200	1.275	1.313	1.313	1.275
1121	2.597	"	"	"	"	"	825	825	863	787	825
1122	2.378	"	"	"	"	"	1.612	1.612	1.650	1.612	1.622
1123	Pure L.	10	90	"	"	"	2.400	2.400	2.400	2.440	2.410
1124	2.587	"	"	"	"	"	863	863	750	863	835
1125	2.588	"	"	"	"	"	900	900	938	1.050	947
1126	2.602	"	"	"	"	"	1.838	1.838	1.913	1.950	1.885
1127	2.597	"	"	"	"	"	1.088	1.088	1.050	1.050	1.069
1128	2.378	"	"	"	"	"	2.175	2.175	2.100	2.138	2.147
1129	Pure L.	12	88	"	"	"	2.475	2.625	2.663	2.438	2.550
1130	2.587	"	"	"	"	"	975	975	938	938	957
1131	2.588	"	"	"	"	"	1.050	1.088	1.088	1.200	1.106
1132	2.602	"	"	"	"	"	2.400	2.362	2.400	2.475	2.410
1133	2.597	"	"	"	"	"	1.013	975	1.050	975	1.003
1134	2.378	"	"	"	"	"	2.850	3.000	2.888	2.962	2.930

Freezing Tests.

1117	Pure L.	.....	Begins to disintegrate after being frozen 16 times	Upper edge destroyed after 25 times.
1118	2.587	.....	Upper edge destroyed.	Can be indented by thumb nail.
1119	2.588	.....	Upper edge worn round.	
1120	2.602	.....	Disintegrates after being frozen 20 times.	
1121	2.597	.....	Begins to crumble after 17 times; disintegrates after being frozen 23 times.	
1122	2.378	.....	Edges slightly worn.	
1123	Pure L.	.....	In perfect condition.	
1124	2.587	.....	" " "	
1125	2.588	.....	Edges worn.	Can be destroyed by thumb nail.
1126	2.602	.....	Disintegrates.	
1127	2.597	.....	Completely disintegrated after being frozen 15 times.	
1128	2.378	.....	Part of upper edge worn.	
1129	Pure L.	.....	In perfect condition.	
1130	2.587	.....	Edges partly worn.	
1131	2.588	.....	Partly disintegrates after being frozen 17 times.	
1132	2.602	.....	Upper edge worn.	
1133	2.597	.....	Disintegrates.	
1134	2.378	.....	In perfect condition.	

of lime we made three sets with different proportions of lime, 8%, 10% and 12% and, moreover, varied the pressure in moulding the test cylinders. Table XV A. contains the test pieces subjected to an initial pressure of 3750 lbs. and table XV B. those compressed under 7500 lbs. of pressure.

The five brands of hydraulic lime employed had the following chemical composition:

	2587	2588	2602	2597	2378
Silica	24.42	16.80	14.97	12.55	24.05
Alumina	7.07	5.33	2.65	2.37	1.41
Iron Oxide	2.37	1.79	0.96	1.49	0.81
Calcium Oxide	52.83	59.88	61.61	63.79	64.77
Magnesia	0.43	0.76	0.14	0.28	0.30
Sulphuric Acid	0.80	0.91	0.50	0.75	0.34
Loss at red heat	11.26	13.94	19.10	16.34	8.55
Not determined	0.82	0.59	0.07	0.43	.....
	100.00	100.00	100.00	100.00	100.23

The pure lime employed originated from limestone containing between 98% and 99% of carbonate of lime, which was calcined and afterwards hydrated.

Table XVI describes the physical properties of the various kinds of lime used.

Made into briquettes with 3 parts of sand, the five brands of hydraulic lime had the following tensile strength after submersion in water for one and two weeks (see table XVII.)

The specific gravity, that is to say the density, of these hydraulic limes is seen to be considerably higher than that of pure lime, especially that of No. 2378 (see table XVI.)

This alone shows that a small quantity of hydraulic lime, and even more so of Portland or natural cement, is not sufficient to coat the sand grains and to effect cementation through the formation of a silicate. Hydraulic limes and cements differ in this respect from pure lime which is light and occupies a large volume.

TABLE XV. B.
Pure Lime Compared With Different Brands of Hydraulic Lime.

No.	Nature of Lime	Pure Lime or Hydraulic Lime perc.	Sand per cent	Initial Compression of Mixture lbs.	Steam Pressure lbs.	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs. per sq. in.				Average
1135	Pure L.	8	92	7.500	120	8	2.287	2.775	2.700	2.775	2.634
1136	2.587	"	"	"	"	"	750	750	712	750	740
1137	2.588	"	"	"	"	"	862	862	862	862	862
1138	2.602	"	"	"	"	"	1.575	1.538	1.575	1.813	1.575
1139	2.597	"	"	"	"	"	938	975	975	975	965
1140	2.378	"	"	"	"	"	1.875	1.913	1.875	1.913	1.895
1141	Pure L.	10	90	"	"	"	3.450	3.225	3.263	3.150	3.272
1142	2.587	"	"	"	"	"	862	900	975	900	910
1143	2.588	"	"	"	"	"	975	975	1.013	1.013	994
1144	2.602	"	"	"	"	"	2.137	2.063	2.063	2.063	2.081
1145	2.597	"	"	"	"	"	1.200	1.238	1.238	1.275	1.238
1146	2.378	"	"	"	"	"	2.850	2.475	2.475	2.475	2.570
1147	Pure L.	12	88	"	"	"	2.775	2.850	3.300	3.075	3.000
1148	2.587	"	"	"	"	"	1.050	1.088	1.055	1.088	1.074
1149	2.588	"	"	"	"	"	1.088	1.088	1.088	1.050	1.076
1150	2.602	"	"	"	"	"	2.512	2.512	2.550	2.550	2.530
1151	2.597	"	"	"	"	"	1.162	1.200	1.162	1.162	1.172
1152	2.378	"	"	"	"	"	2.925	2.887	2.887	3.000	2.925

FREEZING TESTS.

1135	Pure L.	In perfect condition.
1136	2.587	Edges worn.
1137	2.588	Completely disintegrated after being frozen 17 times.
1138	2.602	Upper edge partly indented.
1139	2.597	Same.
1140	2.378	In perfect condition.
1141	Pure L.	In perfect condition.
1142	2.587	Upper edge worn.
1143	2.588	" " "
1144	2.602	" " "
1145	2.597	Slight fissures after being frozen 6 times.
1146	2.378	In perfect condition.
1147	Pure L.	In perfect condition.
1148	2.587	Upper edge slightly worn.
1149	2.588	" " "
1150	2.602	In perfect condition.
1151	2.597	Fissured slightly after being frozen 3 times.
1152	2.378	In perfect condition.

Table XVA and XVB show indeed that, inspite of fair results obtained in the case of some of the test pieces made with hydraulic limes, the test cylinders made with pure lime did all yield higher strength with the exception of one series of tests made with hydraulic lime No. 2378. The sand-lime mixtures containing

TABLE XVI.
Physical Data of Lime and Hydraulic Limes.

No.	Specific Gravity	Residue 100 mesh sieve %	Passing 100 mesh sieve %
Pure Lime	0.406	2.3	97.7
2587	0.792	18.4	81.6
2588	0.652	9.6	90.4
2602	0.643	4.2	95.8
2597	0.540	8.8	91.2
2378	0.858	1.7	98.3

TABLE XVII.
Tensile Strength of Hydraulic Limes.

No.	After 1 week	After 2 weeks
2587	52 lbs.	110 lbs.
2588	52 "	95 "
2602	70 "	110 "
2597	5 "	15 "
2378	82 "	165 "

12% of this hydraulic lime yielded in fact equal or superior results to those made with pure lime, namely 2925 lbs. against 2550 lbs. and 2925 lbs. against 3000 lbs.

The foregoing tests evidently suggest the advisability of making use of a pure lime of as high a grade as possible.

THE PRODUCTION OF HYDRAULIC LIME IN FRANCE.

The manufacture of hydraulic lime in France forms the subject of a pamphlet recently issued by the *Tonin-Industrie-Zeitung*, Berlin, Germany. Its author, Dr. Fiebelkorn, visited the largest factories of Southern France about a year ago and, on his return, described his experience in the above mentioned magazine. The present publication is a reprint from the articles written at that time.

In most countries, the manufacture of hydraulic lime represents a very insignificant part of the total produc-



Silica Stone coming from Hardening Cylinder
(International Sand-Lime Brick & Mach. Co., New York.)

tion of hydraulic cements. In France, however, about as much hydraulic lime is manufactured and used in the most important constructions as Portland cement. The reason for this is to be found in the fact that the manufacture of hydraulic lime was a well-established industry in France at a time when the production of Portland cement was still in a very early stage. The preference that the French engineer then showed for hydraulic lime still exists and will continue to exist in the future, as the excellent hydraulic limes of France have withstood the test of time under the most trying conditions.

The manufacture of hydraulic lime differs from that of ordinary lime only in the higher temperature employed and in the more elaborate and complicated process of hydrating the lime, which finally results in various products, obtained by screening and sifting, from ordinary hydrated lime up to hydraulic limes of the highest water-resisting properties and strength. The product remaining after hydration, called *grappier cement*, closely resembles Portland cement and is ground and used in place of the latter.

The booklet is richly illustrated with photographs and gives a fair opinion of the magnitude of the hydraulic lime industry in France.

The General Cement Products Company has been incorporated at Indianapolis, Ind., with a capital stock of \$25,000.00. They will manufacture cement products. The incorporators were W. J. Wiley, Joseph Zeigler and Charles K. Bogot.

McKeever Engineering & Construction Co., Columbus, O., has been organized by George McKeever, Charles E. Munson, Robert J. Wheaton, Wirt S. Scott and Ernest H. Sims, with a capital of \$10,000.

REINFORCED CONCRETE BRIDGES FOR COUNTRY ROADS.

By J. G. McMillan.

Concrete bridges are rapidly replacing the old style wooden and steel bridges, which formerly were a conspicuous but not altogether an attractive part of our county roads. The wooden bridge is no longer seriously considered by a wide-awake board of supervisors which realizes the many advantages of a reinforced concrete or cement structure.

There is no field of construction in which the use of concrete appeals more strongly to the practical business sense of the farmer than the building of highway bridges. The flimsy and unsightly bridge structures of wood and steel are really more expensive in the end than bridges and culverts of concrete, which are at once beautiful, permanent and fireproof and require no painting or repairs. The somewhat higher initial cost of concrete bridges in some localities has retarded their adoption, but the vastly superior advantages of concrete cannot fail to ultimately impress the intelligent judgment of American farmers generally.

Concrete bridges were initiated into Santa Clara county California, in 1891, the first being a four-ring brick arch laid in Portland cement mortar, the side walls and foundation being of gravel concrete and boulders. There was one span, 36 feet long, with a 24-foot road-way. At the time the contract was let for this bridge, bids were also received on other plans, viz.: Two bids for a wooden bridge, \$490 and \$681; also one bid for a combination bridge, \$690, and one bid for a wooden bridge with concrete piers for \$971. The bid with concrete structure was for \$1,025. The contract was let for \$1,000, the deduction being made in consideration that the contractor leave off the plaster finish on the concrete structure.

There are in Santa Clara county between thirty-five and forty concrete and stone bridges of more than 20 feet span.

The designs are made in harmony with the locality.

In the foothills and mountains, where boulders and field stones are available, they are worked into the structure not only for harmony, but also as a matter of economy. With the proper use of boulders and field stones a saving can be made in labor and cement of 25 to 30 per cent.

Up to 1902 most of the arches were constructed of brick, laid in cement mortar; nevertheless, plans were submitted and bids received both on brick arches and reinforced concrete arches. Until 1904 the cost was in favor of the brick arch, since which time the cost has been in favor of reinforced concrete.

From 1891 to 1904 the cost of concrete, where sand and gravel were close by, was \$5.50 to \$6.50 per cubic yard; in 1907 and 1908 the cost ran up to \$10 per cubic yard.

All the stone and concrete bridges withstood the earthquake of 1906, whereas many of the steel and combination spans were moved from their foundations.

In the East and Middle West many of the county boards are going on record as champions of concrete bridges in preference to all other materials. In Kansas recently the senate passed a bill which provides that the county boards throughout the State must build concrete or stone bridges in all cases where the cost of a concrete or stone bridge is not more than 30 per cent. in excess of the cost of a steel bridge. This notable piece of legislation is a most striking recognition of the merits of concrete and evidence of the growing conviction that this kind of material is the most satisfactory for bridge construction.

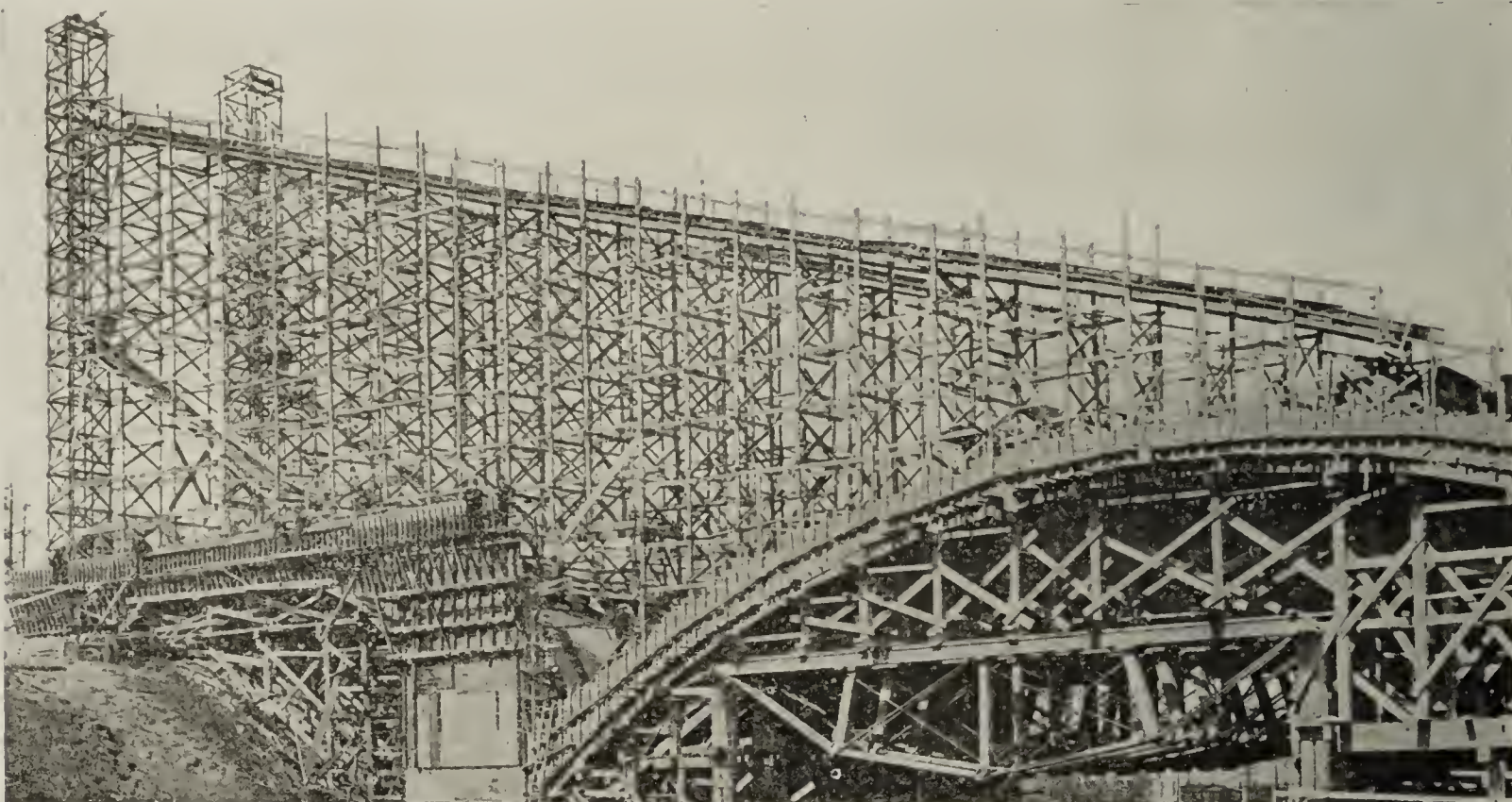
Grand Avenue Viaduct in Milwaukee

A Monumental Masterpiece of Concrete Construction, Combining Beauty and Utility —
A Triumph of Engineering Skill.

After two years of construction work, during which time the engineers in charge were confronted with untold difficulties, which they satisfactorily overcame, the new Grand avenue viaduct over the deep Menomonee valley, at Milwaukee, Wis., is fully completed and is now being used by the proud citizens of Milwaukee, proud of the fact that their city possesses the largest and longest reinforced concrete bridge in existence. From all over the country expert engineers and builders were attracted to the sight of the great achievement to witness the building of the great structure and study the methods employed in its construc-

tion. All of the designs offered were publicly exhibited in Milwaukee for a week, after which, first, second and third prize of \$1,500.00, \$1,250.00 and \$1,000.00 were awarded, the winning designs becoming the property of the county, Ralph Modjeski, of Chicago; Prof. F. E. Turneure, of Madison, Wis., and Gustave Steinhagen, of Milwaukee, composing the committee authorized by the county board to award the prizes.

The requirements called for a concrete roadway, other kinds structures being excluded from the competition, and it was stipulated no piers should be



Towers and Runway for Pouring Concrete.

tion. This viaduct is by far the greatest concrete bridge in the world, its mighty arches towering high in the air and the giant supporting piers present a spectacle which has to be seen to be appreciated. Engineers who have seen the bridge have freely expressed admiration at sight of the work and the general sightseeing crowds view it with awe.

In undertaking a work of this magnitude, the builders expect to be confronted with unique engineering problems which must necessarily be overcome. Added to everyday questions of construction are the practical and artistic points, details of strength and service, and the fact that after the work is finished the achievement must be worthy of the promoters. This project fulfilled all these requirements and the result is a monumental masterpiece which will not likely be eclipsed in simple attractiveness or size for many years.

The citizens of Milwaukee and the county of Milwaukee have justly taken great pride in the work. The designers, the builders and those who furnished the materials have also taken equal pride in having participated in the work, which is one of the world's noteworthy engineering feats.

The plan for the Grand avenue viaduct was obtained on the invitation of Milwaukee county for competitive

placed in the bed of the river; also that necessary clearances be maintained for streets and railway tracks located in the valley.

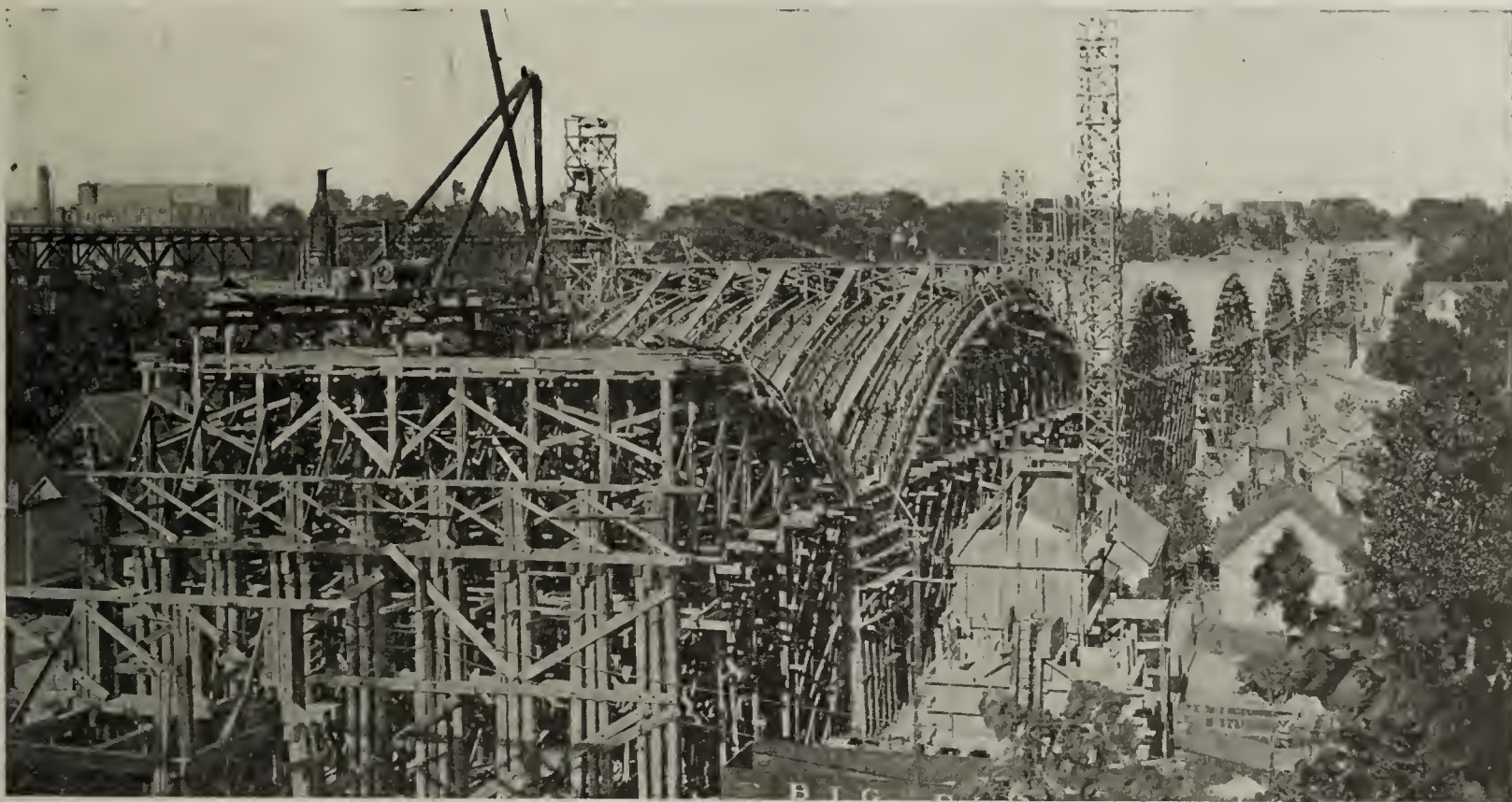
Numerous designs were offered, all of them having more or less merit. The first prizes was awarded to the Concrete-Steel Engineering Company, of New York, with Palmer & Hornbostel, New York, associate architects. This design was considered more simple and effective by the committee because of the absence of ornamental work. The illustration shows the only ornamentation is the courses at the tops of the piers with panels above them bearing up under the cornice and lampposts between the spans. Small panels and other lampposts are located in the center of each span, combined with a balustrade resting on simple molding of massive sections of scroll design.

It was 1908 that the board of supervisors of Milwaukee county announced their intention of replacing the two unstable so-called viaducts that had been doing service since 1886, when the Blue Mound road was for the first time directly connected with Grand avenue, Milwaukee's leading thorough fare.

In the rush to secure prizes twelve concerns prepared plans for the work and the contract was let to the Newton Engineering Company, of Milwaukee. Shortly after building operations were commenced

some difficulties arose between the contractors and the members of the county board. This dispute resulted in the contract being finally awarded to the National Engineering & Construction Company, another Mil-

waukee concern. It is composed of eight arches of 145-foot span, one arch of 80-foot span and one arch of 60-foot span, with earth approaches between concrete retaining walls.



Forms Ready for Pouring Concrete.

waukee concern, and from that time, October, 1908, the work progressed to the finish without a hitch, save for the usual trifling delays in constructions of this kind. Gustave Kahn and J. A. Messiroff, of the National Engineering & Construction Company, were the engineers in charge of the work. Gustave Steinhagen was consulting and supervising engineer for the board of supervisors of the county and city.

The viaduct crosses from Milwaukee to Wauwatosa over the river, a number of railroad tracks and street car tracks and was designed to be part of a com-

The arches were designed and constructed on the regular Melan system, 2 feet 4 inches thick at the crown and 6 feet thick at the tops of the piers. They are reinforced by riveted steel arch trusses. The spandrels are hollow except for 30 feet on each side of the crown of the arches. The concrete in the arch ring is proportioned for a compression of 500 pounds per square inch.

The roadway carries a cushion of earth 18 inches thick, topped with creosote block paving. The arches rest on piers 14 feet thick the full weight of the via-



Under View of the Larger Arches.

prehensive boulevard system and to serve Milwaukee and its environs for time to come.

The total length of the viaduct is 2,088 feet. It is 67 feet wide, with a 40 foot roadway and two 10 foot walks. The single span above the river is 80 feet high, while the other arches tower nearly to that

duct, except for two arch openings 15 feet wide and 30 high to lighten the piers above the continuous footings. Each pier is proportioned for a maximum weight of 10,000 pounds per square foot below the surface of the ground. The viaduct is designed for dead load plus 1,000 pounds per lineal foot, with an

evenly distributed live load of 100 pounds per square foot and 50-ton electric cars added.

The total cost of the viaduct was \$550,000.00, the following statement showing the quantity of the various materials going into the work: Marquette Portland cement, 55,000 barrels, or nearly 20,000,000 pounds of cement; structural steel, 650 tons; steel reinforcing bars, 270 tons; piling, 72,000 feet; lumber, 3,000,000 feet; concrete, 45,000 cubic yards; crushed stone, 36,000 cubic yards; sand, 20,000 cubic yards; excavation, 20,000 cubic yards; earth fill, 20,000 cubic yards.

Throughout the work only the best of materials were used. All of the arches are of monolithic construction, poured concrete. When work was started on one it had to be continued until that particular arch was completed. The average time taken for pouring each arch was fifty-three hours, there being 2,400 tons of concrete in each span of the bridge.

Some trouble was encountered in erecting the span which crosses the right of way of the Chicago, Milwaukee & St. Paul railway, which is 60 feet wide. This trouble was overcome by carrying the form work on a hog train truss.

As it stands now the Grand avenue viaduct is a work to be proud of. It can properly be called the height of achievement in concrete bridge construction, both from an industrial and an architectural standpoint.

INTERSTATE COMMERCE COMMISSION REFUSES TO ALLOW CARRIERS TO ADVOCATE CHARGE.

Washington, April 28.—Refusal of the interstate commerce commission to permit the principal railways of the West to advance their rates on the transportation of cement, for the reason that the carriers are alleged to need additional revenue, is the feature of a decision handed down yesterday in the important Portland cement case.

General advances of from half a cent to 5 cents a hundred pounds in rates on cement were proposed by the carriers in trans-Missouri territory to become effective Sept. 1, 1910, and affected a territory that produces approximately two-thirds of the Portland cement made in the United States.

Cement is a commodity of comparatively low grade in transportation, but in commercial bulk is exceeded only by coal, iron ore and grain. The advances proposed were attacked by producers and shippers, and pending an investigation the commission suspended them first until Nov. 1, 1910, and subsequently until July 1, 1911.

The points of destination to which the proposed rates apply cover a wide range of territory, extending from Illinois and Tennessee on the East to the Rocky mountain territory on the West, and involve rates throughout the country.



Viaduct Practically Complete—North Side Looking East.

PAUL C. VAN ZANDT.

Mr. Paul C. VanZandt has recently become identified with the Stephens-Adamson Mfg. Co. of Aurora, Illinois, and has assumed the management of their Cement Mill Department. His headquarters will be at the company's Chicago office in the First National Bank Bldg., and this branch office will be under his charge.

Mr. VanZandt is a member of the American Society of Mechanical Engineers and a graduate of Purdue University in Mechanical Engineering.

For twelve years he was connected with the Allis Chalmers Co. (and with the Gates Iron Works, which was absorbed by the Allis Chalmers Co.) as mechanical engineer and cement expert. During that time he had charge of that company's mechanical engineering design in the crushing and cement industry, and he designed and installed practically all of the cement plants which they have built.

INTERNATIONAL SAND-LIME BRICK AND MACHINERY CO.

The International Sand-Lime Brick & Machinery Co., of New York, City, has issued a handsome catalogue describing the "Division Method" of making sand-lime brick. Numerous illustrations show the machinery employed, the process of manufacture and the finished product.

WILLIAMS CRUSHER HIGH SPEED METAL.

The Williams Pat. Crusher & Pulverizer Co., of St. Louis, Mo., sells a special metal for the wearing parts of their high speed machinery as crushers, pulverizers, granulators and shredders, which is known as Wing's metal and has proven to be superior to anything on the market as comparative tests have demonstrated.

Manufacture of Cement Drain Tile

A Growing Industry, and the Requirements for its Profitable Business Development.

BY CHARLES E. SIMS,

Secretary, Interstate Cement Tile Manufacturers Association.

(Paper read before Northwestern Cement Products Association.)

The manufacture of cement drain-tile by power machinery was first begun in a small factory in Iowa in 1905. Since that time, 372 factories have been established, with an output conservatively estimated at 150,000,000 feet of four-inch to twelve-inch sizes. Allowing 15,000 tile to drain 160 acres, this quantity of tile would drain over 9,900 quarter-sections of wet land. Averaging the size of these tile at six-inch diameter, and their sale value at \$33⅓ per thousand feet, the total value of the present annual production is \$5,000,000. To this production must be added a further estimate of 1,200,000 feet of the larger sizes of tile—14-inch to 36-inch diameters—having a value of \$300,000. The total value, then, of the power-made cement drain-tile has increased from nothing in 1905 to the value of \$5,300,000 per annum—a rate of growth surprising even to those most intimately acquainted with this new industry.

Distribution of Cement Tile Factories.

State	No. of Factories	Annual Production (Feet)
Iowa	101	40,400,000
Illinois	59	23,600,000
Ohio	57	22,800,000
Indiana	51	20,400,000
Minnesota	26	10,400,000
Michigan	14	5,600,000
Missouri	10	4,000,000
Colorado	8	3,200,000
Arkansas	6	2,400,000
Nebraska	5	2,000,000
South Dakota	4	1,600,000
Mississippi	3	1,200,000
Other states—California, New Mexico, Texas, the Carolinas, etc.	21	8,400,000
Canada	7	2,800,000
Total	372	184,800,000 ft. of tile

It may be of interest to know where these cement tile factories are located. We take the accompanying table from Bulletin No. 17 of the Interstate Cement Tile Manufacturers' Association.

The conditions which have made possible such a rapid development of cement tile making may be stated as follows:

1. The great demand for drain-tile the past few years.
2. The need for frost-resisting and true-shape tile.
3. The money-making possibilities in cement tile manufacture.

The demand for drain-tile the past six years has been unprecedented. Landowners, especially in the northern portions of the Mississippi valley, have seen the benefits from tile drainage, caught the fever, and demanded more tile than the clay factories could produce. Public and private work has been done in these six years to the extent—if we may presume to hazard a mere guess—of more than \$25,000,000 per annum for the tile alone; and the work may be said to be just

begun. In the older States—Illinois, Indiana, Ohio, etc.—the drainage done represents from 40 to 70 per cent of that required; while in Iowa less than 25 per cent is done; and in other States, such as Missouri, Arkansas, Mississippi, and the Carolinas, this industry is still in its infancy.

In the Northern States of this country, the effect of freezing on clay drain-tile at outlets and shallow drains has been serious enough to create a demand for a better material. Within the writer's personal experience may be mentioned an instance to support this statement. A tract of over 30,000 acres in central Illinois has been thoroughly drained within the past twenty years, using clay tile, of course, for that was the only kind made there until a year or so ago. In this work, samples from as many as twenty factories have been subjected to a winter's exposure as a test, and then selection made of the best. As a result, tile have been shipped in 150 miles when there were dozens of factories nearer, some within teaming distance. Nor is this a unique instance, for engineers all over the country have long been specifying "hard-burned," "semi-glazed," or "vitrified salt-glazed" tile—in other words, only the very best quality of the clay-worker's art. Cement tile resist frost so excellently that this fact is one of the most forceful arguments by which they have been introduced.



Interior View of Working Room in Plant of the Cement Products Company, Waterloo, Iowa.

Cement tile are not burned; hence they are true in shape to the mould in which they were formed. One warped tile in a string reduces the capacity of the drain. Where large tile are used for mains, it is important that the full capacity of the size specified be obtained, for it is almost invariably the case that the expense involved prohibits the use of a larger size than necessary. The true shape of cement tile is perfection in this respect—a feature most desirable in drain-tiles.

Machinery people have represented such large profits in cement tile manufacture that it has attracted more attention along that line than it may deserve. It is true that well-located plants under good management have succeeded so far, in many, many instances. On the other hand, there have been some business failures;

and it behooves all who contemplate entering the industry to look well to all the conditions about them. Competition between clay and cement products should not be lightly considered, for on the sizes under eight-inch, it is more than likely that the cement tile manufacturer will find himself unable to compete at a good profit. On the larger sizes, the clay manufacturer is at a disadvantage.

The promoter of a new plant should consider the following conditions:

1. Probable need for tile in the territory about the proposed plant.
2. The labor supply.
3. Quality, quantity, and cost of local sand.
4. Shipping facilities for inbound cement and outbound tile.

as the home manufacturer obtains on his trade. Sand at a cost delivered exceeding one dollar per yard, is dear, and a serious handicap where competition with other factories is keen. Shipping in sand by rail cannot be good practice as a general rule, for it is too expensive.

Cement is too heavy a material, and too sensitive to the weather conditions, to be hauled long distances; hence the factory should not be located far from the railroad. And if the surplus output of the factory is to be sold to advantage, the shipping facilities by rail should be good.

If it were possible to locate a plant so as to conform to all the conditions set forth, there should be no reason why a cement tile factory backed by sufficient brains and money should not do well. Even in the face



Plant of the Worthington Concrete Tile Co., Worthington Minn. Equipped for Operation the Year Round. Curing by Exhaust Steam and Low-Pressure Live Steam.

In considering the need for tile in the immediate vicinity of the plant, it would be well, not only to form some idea of the quantity of them required, but to make note of the probable sizes. Further than that, must be considered whether the public is ready to undertake such work as is obviously needed. The greater the need for tile within hauling distance from the plant, and the larger the sizes, the greater the profits and the better the location.

The labor question has always been a difficult one where heavy work is required; and he who does not have an opportunity to choose his men must expect a difficult task. To make the plant most efficient, locate near a town of at least 1,000 people.

The quality of the local sand bank must be determined before any prediction can be made as to the probable cost of tile made with it. Not only must the sand be clean and sharp, but it must also be well-graded in sizes of particles. Should there be any variation from these conditions, the cost of washing, crushing, screening, and mixing to properly graded sizes should be considered a charge to the plant's disadvantage. Of course, should it be so desired, these handicaps can be overcome largely, so far as the quality of the finished product is concerned, by the use of rich proportions; but in any case the cost of production is increased to the plant's disadvantage.

The amount of sand, and its cost delivered at the factory, are both important. Where the quantity is small, the cost is likely to be excessive also. Where long hauls are required, the labor and superintendence run the cost up until a better located plant may be able to ship its surplus product in at the same profit

of keenest competition, it could take care of itself. Unfortunately, however, cement tile plants have been established with little regard for many of these points; and as a result the individual and the industry suffer.

The history of the past has been one of experiment. In the course of development of machinery and methods, there has been much to learn. That the materials have stood up so well under these circumstances speaks well indeed for the ability of concrete to make good. Ignorant men have worked it into tile; lean proportions and dry mixtures have been used; mistaken ideas on curing the product have been tried; and surprising it is to say that the failures have been comparatively few. But the time is coming when standard practices will be evolved, and a better product will be made.

The present standard equipment of boiler, engine, tile machine, mixer, shafting and belting, sand screen, etc., together with the building and the car system for handling the product, requires an outlay of \$10,000 to \$12,000—this for the common size 4- to 12-inch diameters only. Where machinery is installed for the larger sizes also, the investment for a suitable plant runs up \$3,000 to \$5,000 more. The working capital in the first case should not be less than \$10,000 and in the second case not less than \$20,000 unless the conditions are unusually favorable.

If the industry can be developed with this type of factory, excellent products may be anticipated, for the larger the plant investment, the greater the care taken to establish and maintain a good reputation. Our machinery, however, is new—perhaps undeveloped—and it is a debatable question as to what investment will be justifiable in the future.

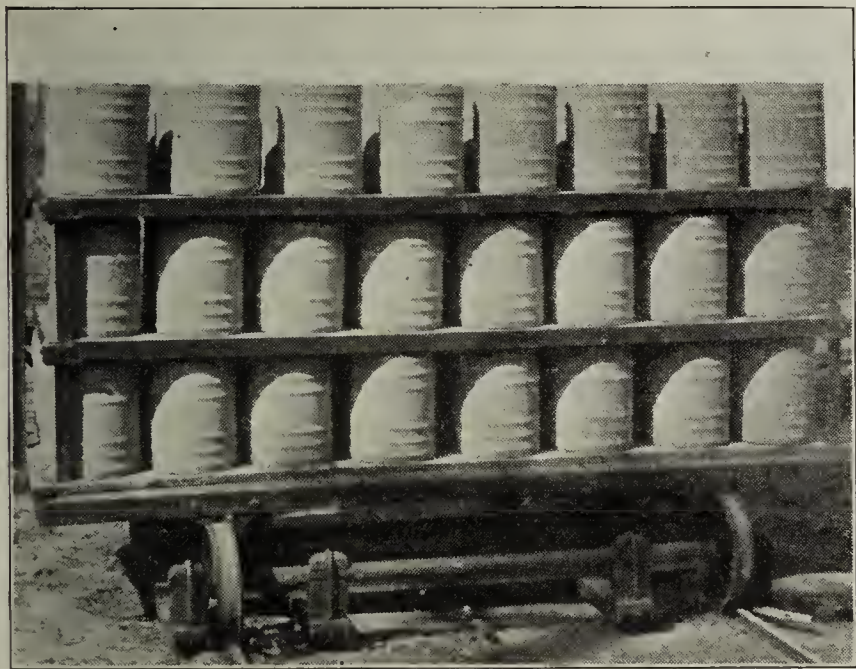
Many difficulties confront the beginner. He has the usual troubles with machinery and labor. He finds new and complex conditions in the use of concrete, from the ever-changing quality of the sand to



View of Steam-Curing Kilns from Inside of Building.

the uncertainties of the packing, handling, and curing. He usually finds himself using more cement than he figured he would need; he cannot attain the rate of production expected; he sees more breakage than he anticipated. When the product is yarded, he finds he must hold it in stock thirty days before it is hard enough to sell. Lack of sufficient stock to meet the summer's demand, tempts him to sell tile less than thirty days old; or, perhaps, lack of capital requires quick sales, for he may not have figured on having to carry so much in accounts, and woe it is.

But the present-day manufacturer has comparatively little to contend with. I have seen it days at a time, when the best efforts failed to secure enough good tile from the machine to pay expenses. The packing device was so imperfect up to a year ago that cement tile making was not a safe business; and the tile produced were so poorly packed that their porosity was



Three-Deck Car Loaded with Tile Ready to be Transferred to Storage Yard.

taken up by some of us misguided would be manufacturers as a talking point for selling them. To-day, conditions are better, for it is now possible to pack the material as dense as desired.

The present-day manufacturer has also the choice of curing the tile either in a damp room or by the steam process. The use of steam has been widely

adopted, for the heat and moisture supplied by it create ideal conditions for curing. Heat cannot be used without the moisture; but in combination, the setting of the cement is accelerated and the tile made ready for use much sooner than without it. It would be a long step in advance if some system should be invented which would make it economical to use temperatures in the curing room as high as 150 degrees; for this would harden the tile much more rapidly than temperatures under 100 degrees, as is the usual practice to-day. We believe the proper construction of the curing rooms is the solution desired.

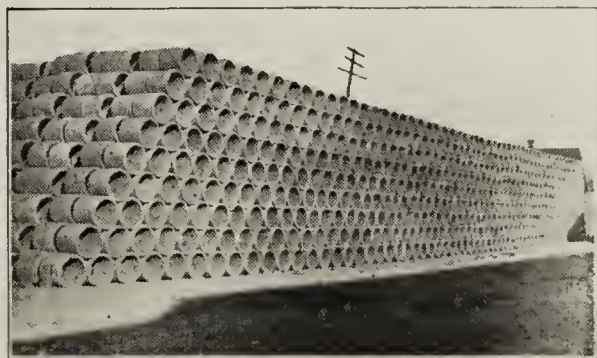
Cement tile have been handicapped especially in public work, by lack of suitable standards. None can say to-day just what requirements any tile—clay or cement—should meet before being passed by the inspector. Recognizing this need, the American Society for Testing Materials is now preparing to investigate the subject, and will probably adopt standard requirements for absorption and for strength. When such standards are in use, the quality of all tile can be determined and the responsibility for satisfactory goods will be placed entirely upon the manufacturer, where it rightly belongs. Heretofore cement tile manufact-



Exterior View of Kilns at Rear of Building, Showing Tile on Transfer Car Ready for Storage.

urers have told the engineers that cement tile become "harder with age"—and that, in truth, is a sterling quality—but the hardest usage frequently comes upon the tile when first laid. It is therefore necessary that standards be adopted and put into practice, but they should apply to all kinds of tile.

Cement tile manufacture is not a royal road to wealth; but it has a fair recompense for the careful, hustling man. As an industry, its future is full of possibilities; and its importance in the drainage field can scarcely be over-estimated.



Pile of "Tens" in Yard of Cement Products Co., Estherville, Iowa.

Layout and Operation of a Cement Drain Tile Plant

By C. M. Powell.

The most important items which claim attention in considering the establishment of a cement tile plant are the amount of land needed and its location, the size and kind of building, provision for cement and sand storage, water system, machinery for handling and mixing the materials and making the tile, power for operating sand and facilities for handling the finished product.

The space needed for the plant will depend somewhat upon the stock kept on hand. This usually varies at different times of the year from practically nothing to perhaps 300,000 tile of all sizes; stocks of 250,000 of the smaller size are not uncommon in the dull season with plants doing a good business. Usually from three to five acres of ground is ample, and if not available it is possible to get along with less without serious inconvenience. The location of the site is perhaps more important than its extent. Close proximity to a railroad and a private siding are very desirable, as it is thereby possible to get materials, at least the cement, delivered to the plant cheaper; besides a much wider market for the product is open when the tile can be loaded directly from the yard into the cars. Some factories have in this way opened up a good dealer-trade, which they have found profitable. Better facilities for shipping large size tile are also obtained, making it possible to secure big drainage contracts.

The size and arrangement of the building will depend very much upon the layout adopted. The newer plants manufacturing all sizes of tile have a total floor space of from 9,000 to 15,000 sq. ft., all of which is practically on the ground level, as the nature of the materials and the process of manufacture do not seem to be adapted to buildings of more than one story.

The kind of construction should be at once durable, fireproof, economical, and easily heated in cold weather. That which immediately suggests itself and seems best adapted is a building with steel roof trusses and concrete block walls with reinforced concrete for the sand bins and roofs of the curing room. A frame building may be cheaper in first cost, but would be neither durable nor fireproof, and hence would not be economical. On first thought it may seem superfluous to make a cement drain tile factory fireproof, but several instances may be cited where plants housed in frame buildings that have taken fire have been completely destroyed.

There are few localities where sand and cement storage would not be required; a certain amount is always necessary to guard against a possible shut-down due to running out of material. A water system is required to furnish water for the boiler, for mixing materials and for curing. Screens and elevators or conveyors for taking care of the sand and gravel with the least amount of labor will prove a big saving in operating expenses.

Tile machines are of two classes, those which make tile 12 ins. long in sizes below 16 ins. in diameter and those which make the larger sizes up to and including those 36 ins. in diameter in either 2 or 2½ ft. lengths. The longer length of large tile is preferable since a tile 30 ins. long can be carted from the machine and the jackets removed as easily as those 6 ins. shorter, and the additional time required for the machine to make the extra length is not one-quarter of that required to make the same size 2 ft. long, because one-fifth of the time consumed in taking the tile from the machine and replacing the jackets is saved.

Machines for making the large tile have not been in

use as long as the others, but are capable of turning out a uniform product much cheaper than can be done by hand. The larger tile are more profitable than the smaller ones and plants where both machines are in operation are certainly the big money makers.

As is the case with most new machines, the strength of the different parts in the earlier models of both machines was not well balanced, but the makers have strengthened the weak parts from time to time, so that now the machines stand the wear and tear very well. However, it cannot be said that they are yet perfect and no one realizes this better than the manufacturers of the machines, as is evidenced by the improvements which are constantly being made.

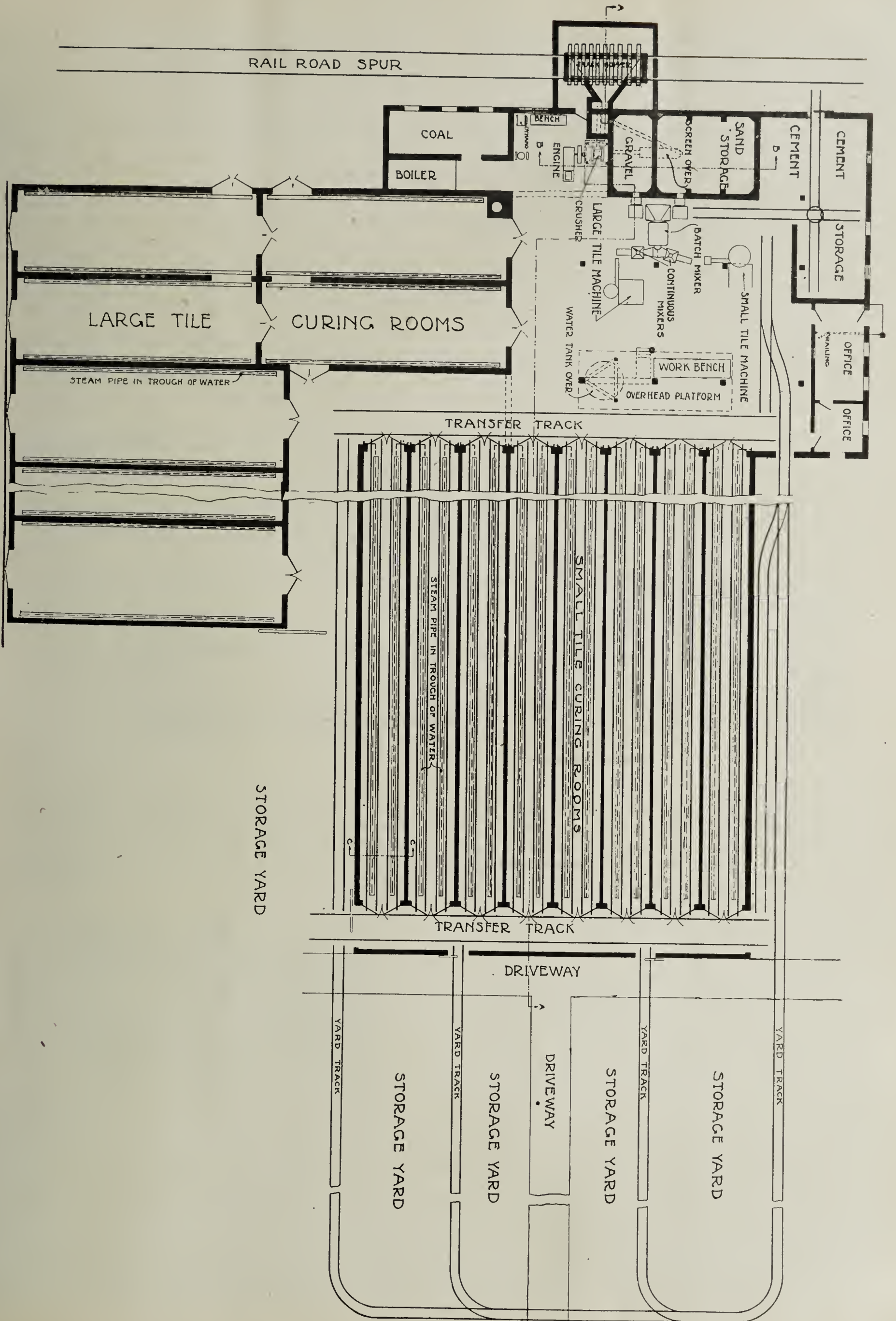
As regards power, it has been found that steam power gives the best satisfaction because it is steady, reliable, and the rated horse power can be depended upon. Since the adoption of steam curing necessitates a boiler, the steam engine is without doubt the most economical. The horse power of both the boiler and engine installed should be sufficient to furnish ample power at all times, and in the long run it will prove more economical to have a little more power than is necessary rather than not quite enough, otherwise the output will be reduced. A 25 to 30 h. p. engine and two 40 h. p. boilers will be ample.

The car system for handling the smaller sizes of tile is the most satisfactory and economical. The number of cars required is naturally dependent upon the production and the length of time allowed for curing. With the time now usually given to curing, 100 cars is the average number used for one machine. The standard car has a 2-ft. gage and a platform 40 ins. wide and 8 ft. long. These cars are equipped with three decks, though four decks are sometimes used when the capacity of the curing chambers is limited. The disadvantage of the four deck car is that the tile on the top deck receives too much shaking or jarring, which increases the breakage materially. The upper decks are supported on a frame and hinged so as to be swung into a vertical position at one side of the car while the deck immediately below is being filled. The decks should be strong enough to hold the weight of all the tile which can be placed upon them without any appreciable deflection and should be constructed so as to give an even surface on which to set the tile. They are usually made with a small angle iron frame and a wooden deck of 1-in. lumber laid crossways of the car. The structural steel used in the construction should not be too light, as thin shapes soon rust under the conditions which exist in the curing chambers, weakening the car and shortening its life.

Cars without springs are much used and give good satisfaction provided the track is well laid and the rails are kept clean and free from sand, mortar and the like. However, springs may be used to take up the jolting of the car, but should be strong enough to allow the men removing the jackets to step on the cars without jarring down the tile.

The capacity of a standard three-deck car for the different size tile is about as follows:

4-inch.....	344
5-inch.....	244
6-inch.....	172
7-inch.....	112
8-inch.....	94
10-inch.....	54
12-inch.....	49



At least two transfer tables are required to handle the cars to and from the curing rooms. In handling the empties the use of switches, where possible, will save labor in operation.

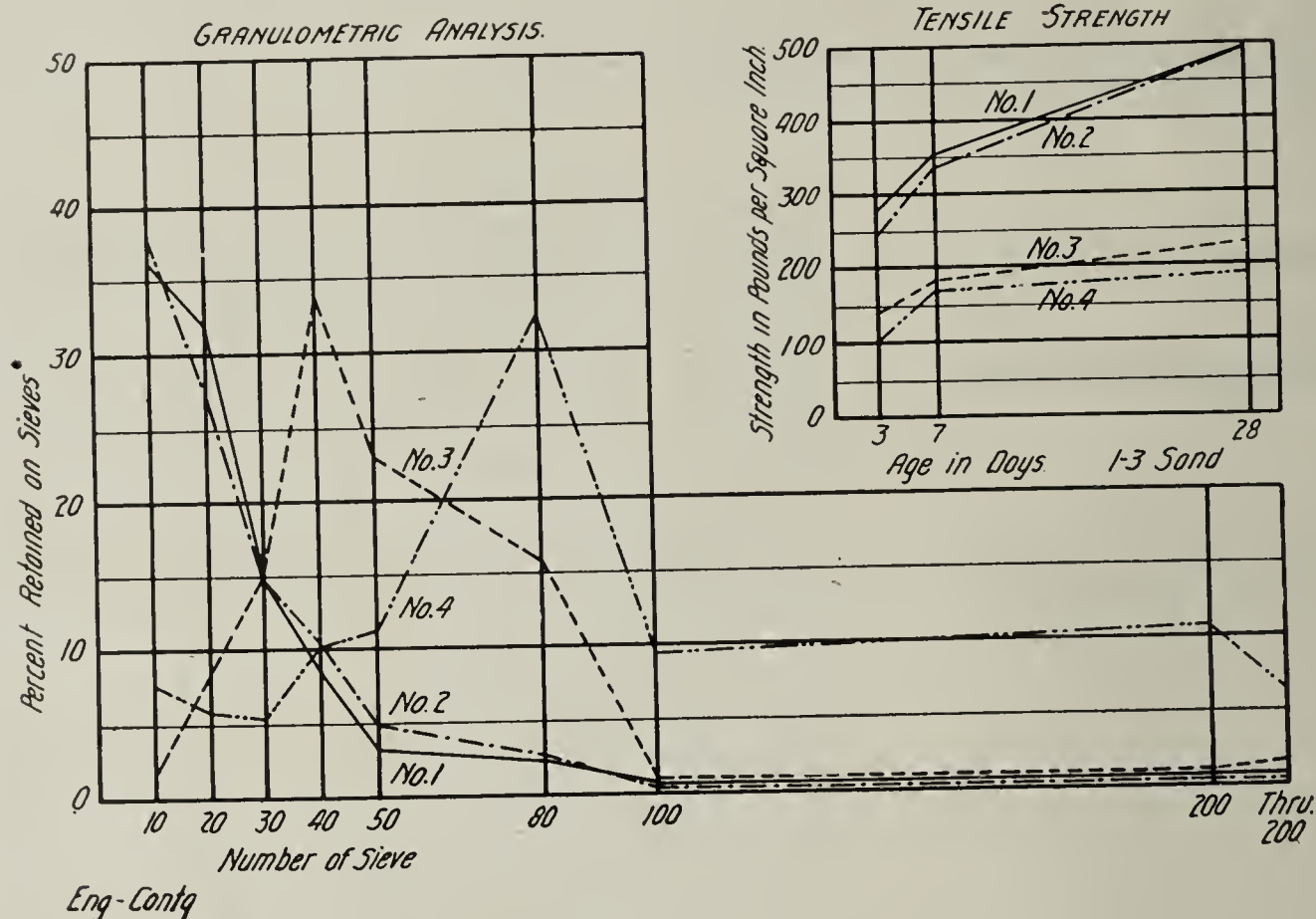
The object to keep in mind in the layout and equipment of a plant is that which will give the largest production of the best tile at a minimum cost for labor, materials and repairs, with the smallest investment consistent with good construction and equipment.

The relationship of one part of the plant to another should be such that the various operations of manufacture can be properly accomplished with ease and dispatch.

Innumerable layouts are possible in any manufacturing establishment and one seldom finds two exactly alike. In suggesting a tile plant layout it is the intention to combine the good points of the various plants

selected as embodying more good qualities than any other. Owing to the conditions existing in the chambers, timber roofs last but a few years; besides they are not fireproof. The roof of the main building is carried upon steel trusses which are supported by two rows of columns and the side walls. A concrete tile roof, although a little more expensive than some of the other kind of roofs, should prove very satisfactory and last indefinitely.

The plan shows the interior arrangement of the plant. The mixing equipment is located directly in front of the sand and gravel bins between the two tile machines, so that concrete may be delivered to either one or both of the machines. The small tile as made are placed on a car at the side of the machine and removed, a carload at a time, over the transfer track to any of the curing chambers. The curing chambers



and to introduce a few new principles and ideas, which it is thought will result in increased efficiency. It is believed that the layout suggested is one which can be operated the year round with the minimum amount of help, and produce a maximum output of the best quality at the smallest cost. The type of construction recommended is the one which seems best adapted to the business, though it requires a somewhat larger investment than the tile manufacturer has put into his plant up to this time, but it is in common use for other classes of factories. There was a time when it was thought that the investment of a few hundred dollars was sufficient to house a tile plant, but that time is passing. The tendency today is to build well and operate the plant on business principles.

The main part of the building is 50x75 ft. and in this are located the office and tile making machines. The sand, gravel, coal and cement storage, engine and boiler room are in the lean-to between the main part of the building and the railroad siding. The curing chambers for the small tile are on the opposite side of the building and those for the large tile are in the rear. A row of windows placed under the eaves, together with the windows in the gable ends, will furnish sufficient light.

The walls of the building are made of concrete blocks with the exception of the sand and gravel bins, which are monolithic concrete reinforced. The roof of the lean-to and the roofs of the steam curing chambers are also of reinforced concrete. This type of roof has been

open onto a transfer track inside the building at the opposite end and by means of a transfer table the cars can be taken to the yard through doors at the end of the track or through doors in the end of the building. The empty cars may be returned back to the machine by running them around on the track at the end of the yard or by being transferred.

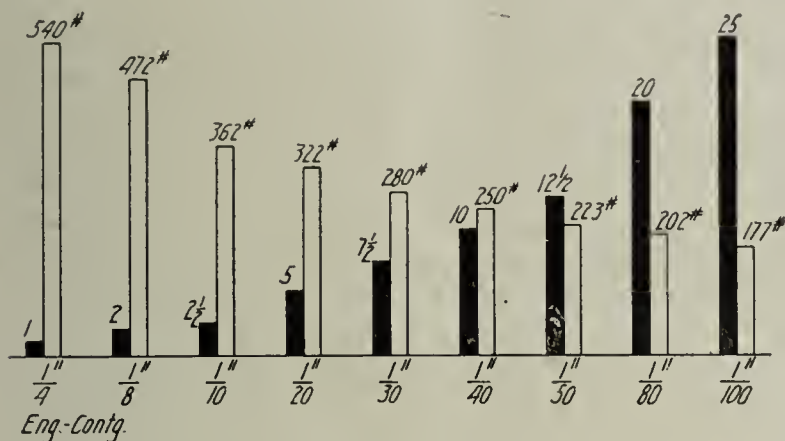
The large tile are conveyed by two-wheeled carts directly from the machine to the curing chambers provided for them and are removed to the adjoining cars. As it is hardly possible to locate both the large and small tile storage yards next to the railroad track, it is advisable where only one siding is available to store the large tile nearest the track, as the small tile are easily handled and most of them are sold to the local trade.

The entrance to the plant is located so that any one hauling tile must necessarily pass the office. The front entrance to the building through which all help and others should be required to pass, is through the office, which facilitates time keeping, etc.

In the main room an overhead platform provides a place for the extra jackets, packer heads, repairs and other accessories not in continual use, and may thus be gotten out of the way. A work bench around which there is enough space available for making such repairs as can be made at the plant, is placed directly under the overhead platform. The boiler and engine rooms are placed next to each other so that one man

can be fireman and engineer. A dynamo is installed in the engine room to furnish light for the plant. A small steam engine is provided to run the dynamo as lighting is required mostly at night when the large engine would not be running.

All the materials are delivered along one side of the plant preferably by cars. The respective storage bins are separated from each other as much as possible to



allow of "spotting" more than one car on the track at a time. The gravel is delivered by car or by wagon and dumped directly into the track hopper, from which it is elevated to the screen over the sand and gravel bins. A gravel bin is provided because it is not economical to make all the sizes of tile with the same aggregate. The sloping sides and bottom of the track hopper delivers all the material to the elevator, which carries the material high enough to spout it over the top of the storage bins to the rotary screen. That part of the material smaller than 1/4-in. in diameter passes through the screen and into the sand bin, while that larger than 1/4-in. and less than 1/2-in. in diameter falls into the gravel bin. All the coarser material is discharged from the lower end of the screen into a chute leading to a small hopper over the crusher, which is placed at the end of the bin. The crusher is set to reduce the materials to about 1/2-in. and discharges the crushed gravel into the elevator, which returns it to the screen. Wet gravel cannot be crushed because it will "ball" up the jaws of the crusher.

The bottoms of the bins are not hoppered or elevated, which allows of additional storage capacity, and the "dead" supply may be shoveled in case the material is required. The aggregates are drawn from the bins through an opening in the side at the floor line into a measuring chute. The flow is controlled by an under-cut gate, placed at the opening in the bin. When the



Part of the Output of a Small Plant at Raymond, Ill.

measuring chute is filled the under-cut gate is closed and the charge is allowed to pour out into the loading skip by opening the gate in the lower end. The cement for the batch is placed in the skip with the sand, which is then hoisted and the materials dumped into the hopper of the batch mixer where they are mixed dry. The mixed dry batch is then discharged into a hopper which feeds uniformly into a pug for wet mixing, and as the feed to the pug is practically uniform, the consistency of the mixture can be easily controlled. One man

should be able to run the batch mixer, as the only material which he has to actually handle is the cement.

The mixing outfit is standard, with the exception of the one-hoppered pug mixer, which is only a modification of one type of continuous mixer. Tile manufacture has been handicapped up to the present time by lack of a mixer which is adapted to the special needs of tile business. An ordinary continuous mixer which, as a rule, proportions the materials mechanically, is in general use in the majority of plants simply because it mixes the materials in the pug mill or mixing trough so they can be used, but the proportioning is uncertain and inaccurate. One manufacturer says that he believes his mixer is costing him \$3 or \$4 per day for the extra cement which he uses in an effort to avoid a lean mixture.

Although the batch type of mixer insures absolutely accurate proportions with but little if any extra labor, it is not adapted to mixing properly sand and cement. These materials, unless mixed with sufficient water to make them semi-fluid, tend to roll and ball, rather than be rubbed and mixed together, as they are when coarse aggregate is in the drum or as they are in the pug. Most any of the standard batch mixers will mix thoroughly the dry sand and cement. The combination recommended in the layout, if properly operated, would overcome all the mixing troubles which have heretofore been experienced.

There are many things in connection with the operation of a tile plant which require constant attention.



Another View in Yard of Cement Products.

but only a few of the most important ones will be discussed here. One of these, and one which does not receive the consideration which its importance warrants, is the selection of materials. Only the best materials should be used, because the most improved machinery and the best methods of manufacture cannot be expected to produce a good quality of cement tile from anything else. The question of cement may be dismissed with the suggestion that only Portland cement, which will meet the requirements of Standard Specifications, be used.

Too often the consideration of cost plays the important part in the selection of the aggregate, but this is gradually becoming at least partially subservient to those qualities which will produce the required results. Unless the aggregate is from a deposit of known quality, experience has shown that it should be tested. Heretofore there has been too much of a tendency to regard "sand as sand." Natural deposits of sand or gravel may be or may not be suitable for cement work and only an investigation will determine their relative value.

If only one sand is readily available tests may show that sand obtained from another source at an increased cost will improve the quality of the product sufficiently to justify the extra expense in obtaining it. Again, it is but rarely that any two sands are of the same quality and a study of their physical characteristics will determine which of a number, that may be used, is best suited for the work.

In the selection of sand too much emphasis cannot be placed upon the value of coarse and properly graded particles. It is a well known fact that coarse sands are superior to fine sands for concrete, yet it is surprising how much fine sand is used for making tile. Fine sand has a greater number of particles per unit volume than coarse sand, and consequently more points of contact between the grains, therefore, it requires more water for the same consistency, more cement to coat the extra surface area, and is more difficult to mix properly. The water required is sufficient to separate the particles by surface tension, increasing the voids in the mortar, thus decreasing its density and strength. The relative value of coarse and fine grained sands is clearly illustrated by the diagram, Fig. 2. Assuming the short column (1) represents the surface area of a half bushel of spheres or sand grains, all of which are $\frac{1}{4}$ -in. in diameter, the other column represents the surface area of a half bushel of spheres or sand grains, all of which are of the diameter indicated by the figure over each column. This diagram shows very forcibly that with the same measured amount of sand the surface area varies greatly with the size of the sand grains. The surface area of a quantity of spheres or sand grains, 1-100-in. in diameter, is 25 times greater in the same quantity of spheres or sand grains $\frac{1}{4}$ -in. in diameter. The open columns indicate the relative strength of test pieces made with one part cement and three parts sand, separated into various sizes. As the various sized particles were separated from the same original sample, it is reasonable to state that the difference in strength is entirely due to the size of the particles. It is interesting to note how rapidly the strength is decreased by the increase in the fineness of the sand.

A sand may contain a sufficient quantity of the smaller sizes to make it suitable for tile and still be scarce. This is illustrated by the results of tensile and sieve tests, as shown on the diagram, Fig. 3. Curves 3 and 4 show that these sands have an excessive amount of material retained on the 50 and 80 sieves with a corresponding decrease in strength of the mortar. Curves 1 and 2 represent good, coarse sand. Sand 1 has too much of the coarser sizes to be entirely suitable for making the smaller sizes of tile, although it is an excellent sand for large tile and general concrete work. Sand 2 is coarse, excellently graded and is an ideal sand for making tile. It is important that the individual sand grains be hard, as the mortar can be no stronger than the sand from which it is made.

An aggregate, either sand or gravel, containing any considerable quantity of shaley particles must be avoided, as such material is weak and may be disintegrated by frost. In the glacial gravel deposits of the Upper Mississippi Valley these soft, shaley pebbles are sometimes found in considerable quantities. In some of the river sands "lignite" proves troublesome. "Lignite" is a poor quality of coal, containing the texture of the wood from which it is formed, black in color, brittle and easily broken between the fingers. The larger sizes may be removed by screening, but even so, the smaller particles remaining expand during the hardening of the mortar, and those near the surface "pop out," disfiguring and weakening the tile.

Sand should be free from clay, loam, mica, or an excess of fine material, even though siliceous. It is not the presence of the clay or loam to a limited extent, but the manner in which it is present, that does the damage. The sand grains, themselves, must be free from a coating of foreign material. A simple and effective test for detecting such a coating on the sand grains is to wash a small sample by shaking it up in a bottle or jar with water, and after pouring off the

water and drying the sample, to compare it with some of the untreated sand. If there is any appreciable difference in the color of the two, there is evidently a coating on the grains. Such sand will produce a weak mortar, because the cement cannot form a good bond with the aggregate, and the fracture of the mortar shows that the grains pull out of the cement, leaving little pockets lined with a thin film of clay. The use of such sand is apt to result in failure.

When cement tile was first made by machine very lean mixtures were used, but it was soon learned that this was objectionable, and the best practice now is to use for the tile 10 ins. and smaller, a mortar composed of one part Portland cement and not to exceed three parts of fine aggregate. For the larger sizes it is more economical to use concrete instead of mortar, the diameter of coarse aggregate being limited so as not to exceed one-half the thickness of the tile walls. The proportions for the concrete should be 1 part cement to not more than $2\frac{1}{2}$ parts sand, with as much coarser aggregate, up to 4 parts, as can be used. With some materials the mixers may not carry four parts of coarse aggregate without causing trouble by the green tile falling down when stripped.

One of the most important things to watch in making tile is the consistency of the mix. The amount of water which it is possible to use in the mixture for machine made tile is at the best not sufficient to develop the full strength of the cement, and for this reason the mix should be made as wet as can be used. When the jackets are removed the tile should show water marks on the outer surface, that is, web-like markings, indicating free moisture. Although it is generally recognized among cement tile manufacturers that tile showing water marks are the strongest, this matter is not given sufficient attention. The tile made from a dry mix are not so apt to stick in the jackets as are those made from a wet mix, they stand up better, which probably explains why so many manufacturers use a dry mixture. Sticking to the jackets is easily overcome by holding the tile, before removal of the jacket, horizontally and hitting the end against the table of the machine just enough to loosen the tile from the jacket. The same thing is accomplished by setting the tile down hard on the car, but this thickens the walls at the end and is objectionable.

Because of an insufficient amount of water in the original mixture, every particle must be conserved, which is impossible if the tile are cured under normal atmospheric conditions. The object, therefore, in steam curing is to create an atmosphere saturated with moisture in a chamber sufficiently air tight to eliminate all possible draughts. It is not the intention to supply moisture to the tile, but to protect it perfectly against the loss of any moisture which was introduced when mixing the concrete. As a saturated atmosphere is required, the use of dry steam or steam under pressure is out of the question. Some plants are operated today by the use of such steam, and in parts of the curing chamber fairly good results are obtained, because the steam condenses in these parts, while product placed near the point at which the steam enters the curing chamber is poor, owing to the drying action of the steam. This condition is naturally aggravated in warm weather because the steam does not condense so readily. Only by the use of steam curing is it possible to obtain uniform conditions throughout the year. The safest and most satisfactory way of admitting steam into the curing chamber is through a perforated pipe, which is placed, perforations down, in a water-filled trench in the concrete floor of the room; the steam passing out into the atmosphere through the water naturally be-

comes saturated. The floor in the curing chambers is sloped toward the trench so that the water in the trough is constantly replenished by condensation. In this way there is little danger of excessive heat, for as long as the steam passes through the water the temperature, no matter what it is, cannot have a drying effect. The nearer the temperature approaches the maximum possible with this method, the more efficient does the curing chamber become, for moist heat accelerates the hardening of the tile. With this scheme exhaust steam will not furnish sufficient heat during cold weather, therefore it is best to take live steam direct from the boiler. Tile should be run into the curing chambers as soon as made, but it is not advisable to start the steam until the tile have stood about an hour, especially in cold weather, because condensation will be very great until the chamber and the tile become heated up, and the gathering of moisture on the tile may be sufficient to damage them.

To operate the suggested plant to full capacity on all sizes of tile will require a foreman and about twenty men, distributed as follows: One engineer, one man running the mixer, one man feeding each tile machine and one operator on each machine, one man removing jackets from small tile, one handling cars and four yardmen, who remove the tile to the yard, load wagons and do odd jobs about the plant when not otherwise engaged, two men will always be needed, wheeling the large tile from the machine and sometimes three, one man removes the jackets and two men, with the help of the one man, sometimes used for wheeling tile, can remove the tile to the yard, load wagons and cars; a night man will be required to keep up steam, clean, repair and change the machines.

In order that no tile may be removed from the curing chambers too soon it is well to have the man handling the cars of small tile to the curing chambers keep a record of the number of tile of each size on each car and the number of cars placed in each chamber. The man removing the jackets from the large tile can keep a record of the number of each size placed in the different chambers, these records to be handed in at the office twice a day. By this practice a memorandum, showing the number of cars and the number and size of large tile in the different rooms, which are to be put in the yard that day, may be given to the yardmen every morning. From these records can be compiled the day's output and the stock on hand. Some allowance must be made for breakage, otherwise the number of tile in the yard will not agree with the number of tile made by the machines.

The arrangement of the stock piles should be such that the wagons may be loaded with any size and leave the yard by crossing the fewest number of tracks. This is accomplished best by piling the tile in long rows, parallel to the track. The distance between tracks may be anything desired. Some prefer not to have a greater distance than 20 ft. between the center line of the track and the center of the roadway. Others have found that a distance of 50 to 75 ft. to be a convenient width. In the latter case, to avoid carrying the tile long distances when unloading the cars, they are rolled down a chute, about 14 in. wide with 4-in. sides and 20 to 24 ft. long, one end of which is placed on the edge of the second deck of the car. The tile can be rolled 30 to 35 ft., and this method proves very satisfactory for all the small tile larger than 5 in. If the sales are large during the winter months, it is desirable to place the stock piles on a layer of straw or other material, as it is very often that the lower row of tile freezes to the ground, which prevents the wagon from getting close to the pile, and they cannot be loaded without

much extra labor, if something of this kind is not done.

It is the best practice in loading tile either in wagons or cars to lay them horizontally, instead of standing them on end. They should be packed as closely as possible with no play; especially is this true in loading cars. Good cement tile, when properly loaded, can be hauled or shipped a considerable distance with little or no breakage. Switching partially loaded cars will cause excessive breakage. A car load of 30,000 lbs. will contain approximately

4,300 ft. of	4-in.
3,400 ft. of	5-in.
2,750 ft. of	6-in.
2,000 ft. of	7-in.
1,500 ft. of	8-in.
100 ft. of	10-in.
800 ft. of	12-in.
600 ft. of	14-in.
500 ft. of	15-in.
400 ft. of	16-in.
300 ft. of	18-in.
250 ft. of	20-in.
210 ft. of	22-in.
200 ft. of	24-in.
175 ft. of	26-in.
150 ft. of	28-in.
125 ft. of	30-in.
110 ft. of	32-in.
85 ft. of	36-in.

MEDUSA WATERPROOFED CEMENT.

We are pleased to announce to our customers that we have commenced the manufacture of Waterproofed Cement at all our mills.

The Waterproofed Cement consists of Medusa Waterproofing ground with our gray cement, thus dispensing with the trouble and expense of the user mixing it dry with the cement and at the same time getting a more uniform mixture.

The price will be based on the market value of cement at time of sale, plus the cost of Waterproofing, and a small allowance for the extra cost of grinding. This new product can be shipped in large or small quantities from any of our mills in cars containing our gray cement.

Medusa Waterproofed Cement will dispense with any further question concerning the practical use of cement blocks, exterior cement plastering and cement roofs.

It will be found especially adapted for use in storage tanks, cellar walls, cisterns, reservoirs, swimming pools, concrete conduits, sewer pipe, elevator pits, dams and a multitude of other uses in which resistance to percolation of water is required.

SANDUSKY PORTLAND CEMENT CO.

The Oklahoma Portland Cement Co., Ada, Okla., has completed a pipe line from artesian wells at Lawrence, eight miles south, for use in its plant.

The T. R. Mills Lime & Brick Company has been incorporated at Little Rock, Ark., with a capital stock of \$90,000.00.

J. A. Kuster of Plymouth, Wis., has begun the erection of a cement products factory and will turn out all kinds of cement blocks, bricks, balustrades and other ornamental concrete work.

THE ZAGELMEYER SYSTEM OF CASTING HOLLOW CEMENT BUILDING BLOCKS.

The concrete building block industry has reached a stage where the building public demand a better article than it is possible to make on the old "dry tamp" system, with its imperfect and uncertain results, and which produces at its best a very inferior and oftentimes dangerous article for building purposes. This system has outlived its usefulness and must now give way to more scientific methods.

It has been known for some time by all practical concrete engineers that concrete building blocks made by the so-called "wet mix" system, are about twice as strong as blocks made by the usual "dry tamp" system, and at the same time overcome that greatest of all objections to all blocks now made—their porousness. All blocks now made on the "dry tamp" system, no matter how carefully made, or how well tamped, are full of pores and will always soak up moisture like a sponge. This is a very serious objection and

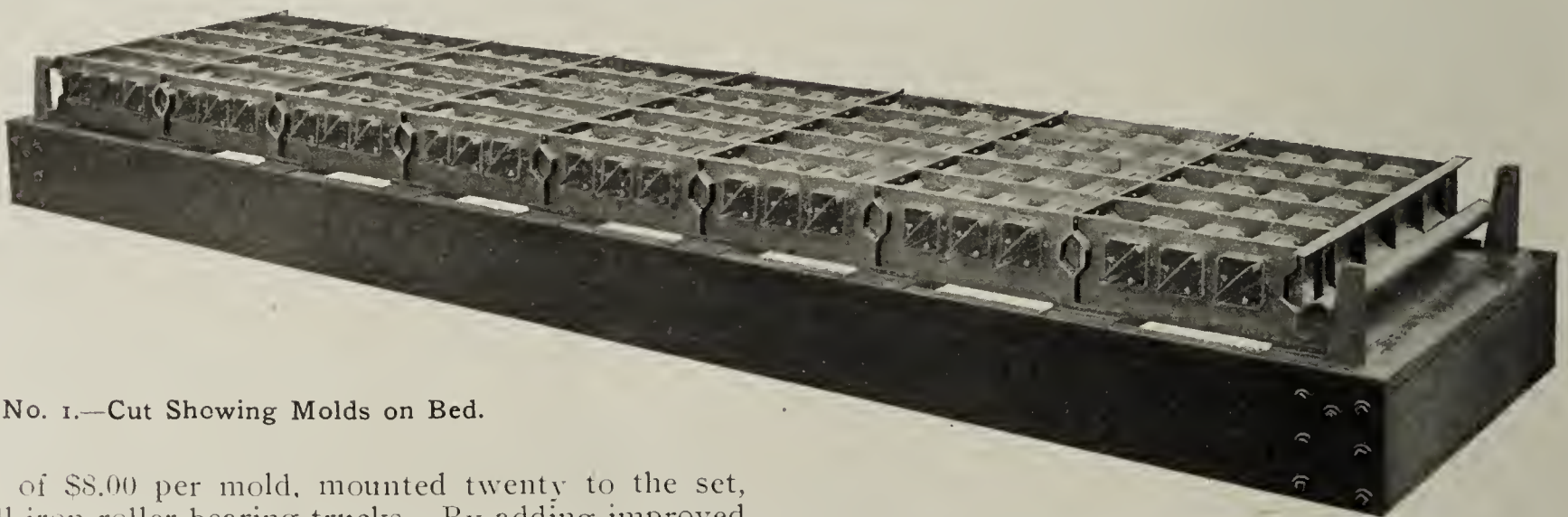


has done more to retard the general adoption of concrete building blocks by architects and builders than any one thing. If a block is made on the wet mix system—that is, if the concrete is mixed wet enough so it can be poured directly into the mold and allowed to remain there while the cement takes its initial set, no tamping is required, and the result is an absolutely **waterproof** block, with the greatest possible strength.

The great objection in the past has been the enormous cost of the molds; the Zagelmeyer system, however, overcomes this objection; their first molds were a marvel of simplicity, efficiency and cheapness, and were placed on the market at the astonishingly low

This system consists of filling multiple molds, mounted either on trucks or a stationary bed with liquid concrete, and allowing the concrete to take its initial set before removing the blocks from the molds. The length of time required for the set to take place and the blocks to harden sufficiently to remove, depends entirely upon the temperature of the air. At ordinary summer temperature the blocks can be removed in from twenty to twenty-four hours, so that in summer weather the molds can be used once per day without artificial heat. By applying heat and keeping them in a temperature of 120 degrees F. they can be removed in twelve hours, and the molds can be used once each day and once each night, or two times in each twenty-four hours. By increasing the temperature to 180 degrees F. They can be removed in six hours or two times each day and two times each night, or four times each twenty-four hours. The best method of applying artificial heat to the cars is with a series of small tunnels, heated with steam pipes, each tunnel just large enough to admit a car of molds; the number of tunnels, of course, depending upon the capacity required. Tunnels of wooden construction are used for temperatures up to 125 degrees F. An ordinary house-heating boiler will furnish steam for forty of these tunnels, and the cost of same with piping and boiler all complete, is only \$600.00. Each tunnel will cure fifteen 8-inch or 12-inch blocks in the coldest winter weather, or 30 blocks each twenty-four hours during the summer months. This gives a capacity of 600 8-inch, 10-inch or 12-inch blocks per day in winter, and 1200 per day in summer; the latter capacity requiring a day crew and a night crew. This heating arrangement is so simple that it requires no more attention than steam heat for an ordinary dwelling house, and the cost for fuel is less than one-tenth of a cent per block. To run the above number of tunnels to their full capacity requires 42 cars of molds, 40 to keep the tunnels full and two in use.

A few tunnels can be built and a few cars of molds purchased to start with, and more cars can be added as desired. The price at which these blocks sell for over all other makes, will soon supply money to buy more cars. Every customer is a satisfied one and brings another, and in this way the trade increases and soon develops into a permanent and profitable business.



No. 1.—Cut Showing Molds on Bed.

price of \$8.00 per mold, mounted twenty to the set, on all iron roller-bearing trucks. By adding improved machinery for manufacturing them, and by recent improvements in the design, the Zagelmeyer Cast Stone Block Machinery Co., of Bay City, Mich., is now able to sell the latest style of 8x8x24-inch molds (which are a decided improvement over the old style), mounted on all iron, especially designed, roller-bearing trucks, fifteen to the set, at \$80.00, or \$5.34 per mold, or unmounted in quantities at \$3.75 per mold.

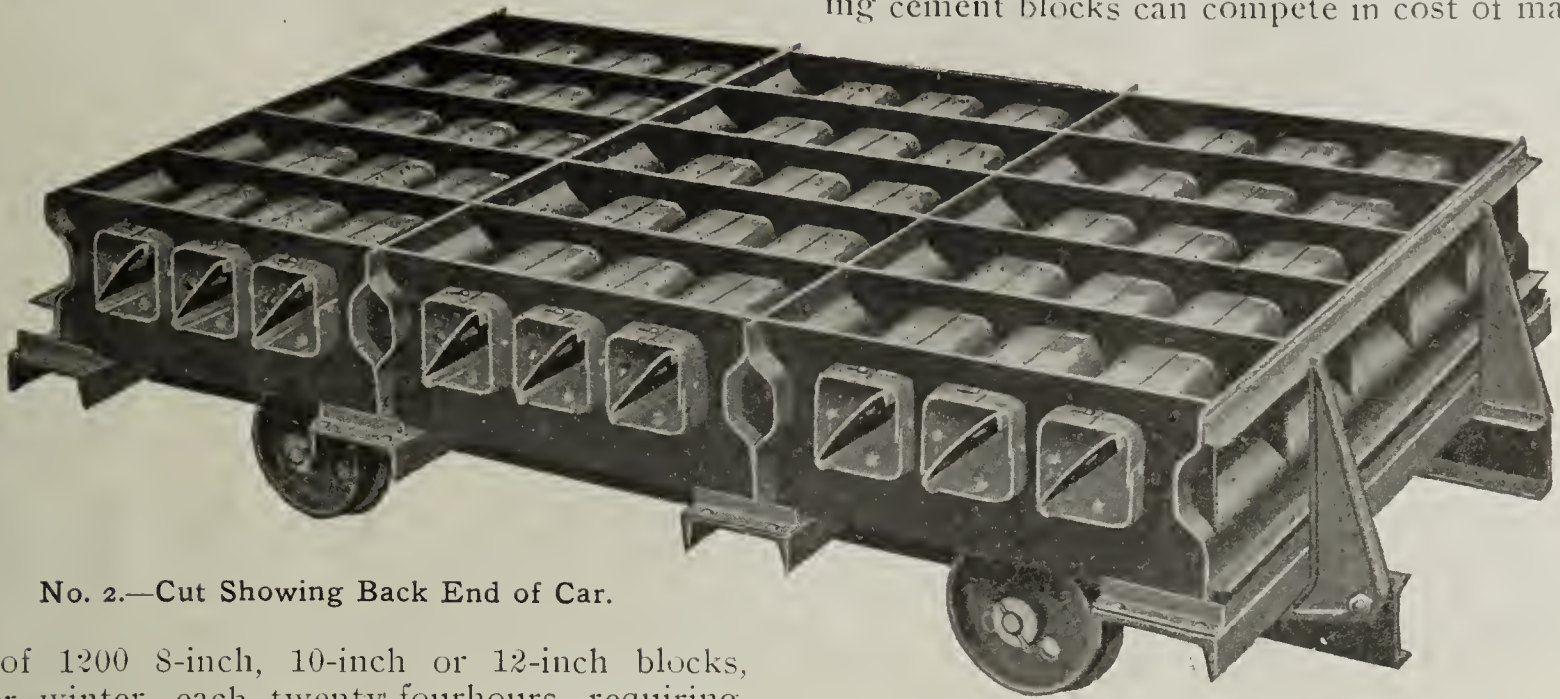
High Temperature Tunnels.

Tunnels for a temperature of 180 degrees F. must be built of concrete or brick, must have more steam radiation, and high pressure steam must be used. Twenty high temperature tunnels can be built for \$1,000.00, including steam coils and twenty-five H. P. boiler. In case the boiler cannot set low enough so the condensa-

tion from the tunnels will drain back, an automatic receiver and pump must be installed; a good one of the necessary capacity can be bought for \$100.00, and it must be placed in the pit, thirty inches below floor of ovens. Twenty tunnels as above described have a

as a more perfect face is obtained and the bond between the body and the face of the block is absolutely certain.

The entire operation is so simple, and the amount of labor required so little, that no other method of making cement blocks can compete in cost of manufacture.



No. 2.—Cut Showing Back End of Car.

capacity of 1200 8-inch, 10-inch or 12-inch blocks, summer or winter, each twenty-four hours, requiring both a day and a night crew. To get the most economical results from high temperature tunnels, they should run day and night. When run day times only, considerable heat is wasted by the tunnels cooling off over night, and it takes some time to get them heated up again in the morning. Twenty-two cars of molds will run the above described tunnels to their capacity.

Cut No. 1 is a half-tone taken from a photograph, showing forty of the standard 8 x 8 x 24-inch molds, with 4 x 4-inch cores, mounted on a stationary bed. By applying steam to the coils and covering molds with a canvas, the blocks can be removed in seven hours or less.

Cut No. 2, shows back end of car.

As the block remains in the mold undisturbed until

THE CEMENT TILE MACHINERY CO. WATERLOO, IOWA.

A handsomely illustrated catalogue of unusual proportions issued by the Cement Tile Machinery Co., of Waterloo, Iowa, describes in detail every machine, tool or appliance used in the manufacture of concrete.

The Schenk Cement Tile Machine, one of the foremost inventions of the company, is shown in operation on several cuts. The Schenk Packer and Tile and Pipe Molds are dealt with next. Hereafter, Concrete Mixers, Concrete Block Machines and Tile and Block Cars for handling the moulded pieces are described in detail. Also machinery for the manufacture of cement brick and cement fence posts are illustrated, so that



the cement is set with plenty of moisture, perfect hardening of all cement is assured; even the semi-dry facing absorbs enough water from the wet concrete above it to perfectly harden, and at the same time makes it plastic enough so that the weight of the very plastic mass above forces it into all corners, and the result is a sharp, clear impression of whatever design the face-plate contains. Thus a much stronger as well

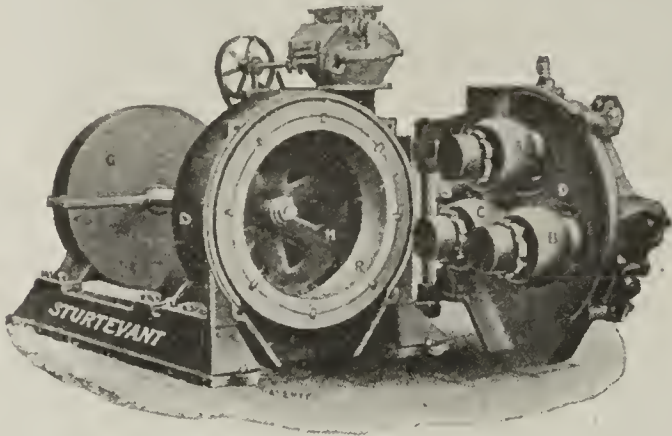
not a single phase in the manufacture of concrete products has been overlooked. Every up-to-date contractor should send for a copy of this pamphlet.

Acme Building Supply Co., Meridian, Miss., has been incorporated by C. L. Gray, R. C. Malone and John L. McLemore, with a capital of \$50,000.

STURTEVANT RING-ROLL PULVERIZER.

The Ring-Roll Mill, manufactured by the Sturtevant Mill Co., 117 Clayton street, Boston, Mass., differs from other cement pulverizers of the roller mill class, and because of this difference the manufacturers claim great advantages.

Its grinding action is best illustrated in the "working" cut shown herewith. It will be seen that the product from an ordinary crusher (2" and finer) is automatically fed through the spout and delivered at the centre of a wide revolving ring or tire, where it is firmly held by the centrifugal force, generated by the ring's rotation thus forming a thick protective layer of rock



Ring Roll Mill with Door Open Showing Accessibility of Rolls.

1" in thickness over the entire surface of the ring.

The three convex-faced rolls (all set up by one adjusting screw on the outside of the door) are strongly and equally pressed by springs towards the revolving concave face of the ring. They are forced by frictional contact, with material thereon, to roll over and pulverize it by the centrifugal force, generated by ring rotations, which holds material on the ring until it is crushed fine. Then the rolls crowd the fines off of both sides of the ring's track as fast as produced. A naked track is never exposed to the roll faces. Rock is crushed down upon itself (between the anvil ring and hammer roll) producing a maximum of fines, with least wear, it is claimed.

The spring-pressed rolls are adjusted to crush at from 20,000 to 40,000 lbs. pressure. This is greater than the track pressure of locomotive wheels; and the high-power steel axles of the Sturtevant mill are stronger. These elastically and equally pressed rolls are balanced and pass over iron or uncrushable substances with shocks so completely cushioned that crystallization or breakage is prevented.

As there is a constant feed while the mill is at work, of coarse and partly reduced material, so there is a con-

stant drop of material crushed off of both sides of the ring by the rolls. This escapes to the bottom of the case, whence it is taken to a Newaygo screen to remove the finished product as soon as made. The tailings are returned to the ring (with fresh feed) for further reduction. Thus the mill is always grinding new material, and producing a maximum output. The driving shaft carries only the weight of the parts which it revolves. It takes no crushing shocks. The roll pressures are exactly equal and opposite, and the stresses exactly balance and offset each other.

With the open door arrangement, the whole front of the mill case opens like the massive door of a safe, and carries the rolls and all their parts entirely outside of the mill, exposing the whole interior. The ring (R) which is the only working part left inside, can be quickly reached. When the door closes, it swings the rolls back into the interior space of the ring (R) and then all are equally and elastically pressed by one screw on the outside of the door, and as strongly as is needed to crush at once any grindable material held on the ring. The ring (R) discharges its rock on both sides of the concave track. Ability to open the door quickly often saves time, an important consideration, even in small works. The mill case has other openings, too, that are convenient.

Actual tests with these machines show the following results: Cement clinker, 60 barrels per hour to 20 mesh 15 to 20 barrels per hour to 97%-100 mesh. Limestone, 10 tons per hour to 20 mesh; 5 tons per hour to 98%-100 mesh. Power tests show 25 to 30 h. p. for fine work and 30 to 40 h. p. for preliminary grinding.

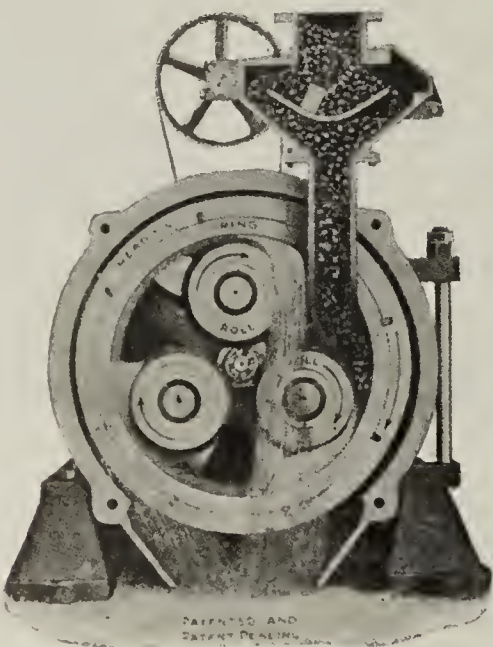
IMPORTANT PATENT DECISION.

"Several years ago one of our patents involving the hinged hammer principle characteristic of the Williams mill was infringed by the St. Louis Pulverizer Company, and the Circuit Court of the United States at St. Louis entered a decree which carried with it an injunction, an accounting and costs. The opinion of the court in this case is published in Volume 104 of the Federal Reporter, page 795. Said St. Louis Pulverizer Co., went out of business.

"We have just received a copy of the decision in a suit recently brought against the Pennsylvania Crusher Company, for infringement of claims in another one of our patents. The United States Circuit court of Appeals for the Third Circuit orders that a decree be entered in our favor, which decree will carry with it a perpetual injunction, an accounting for damages and profits and costs.

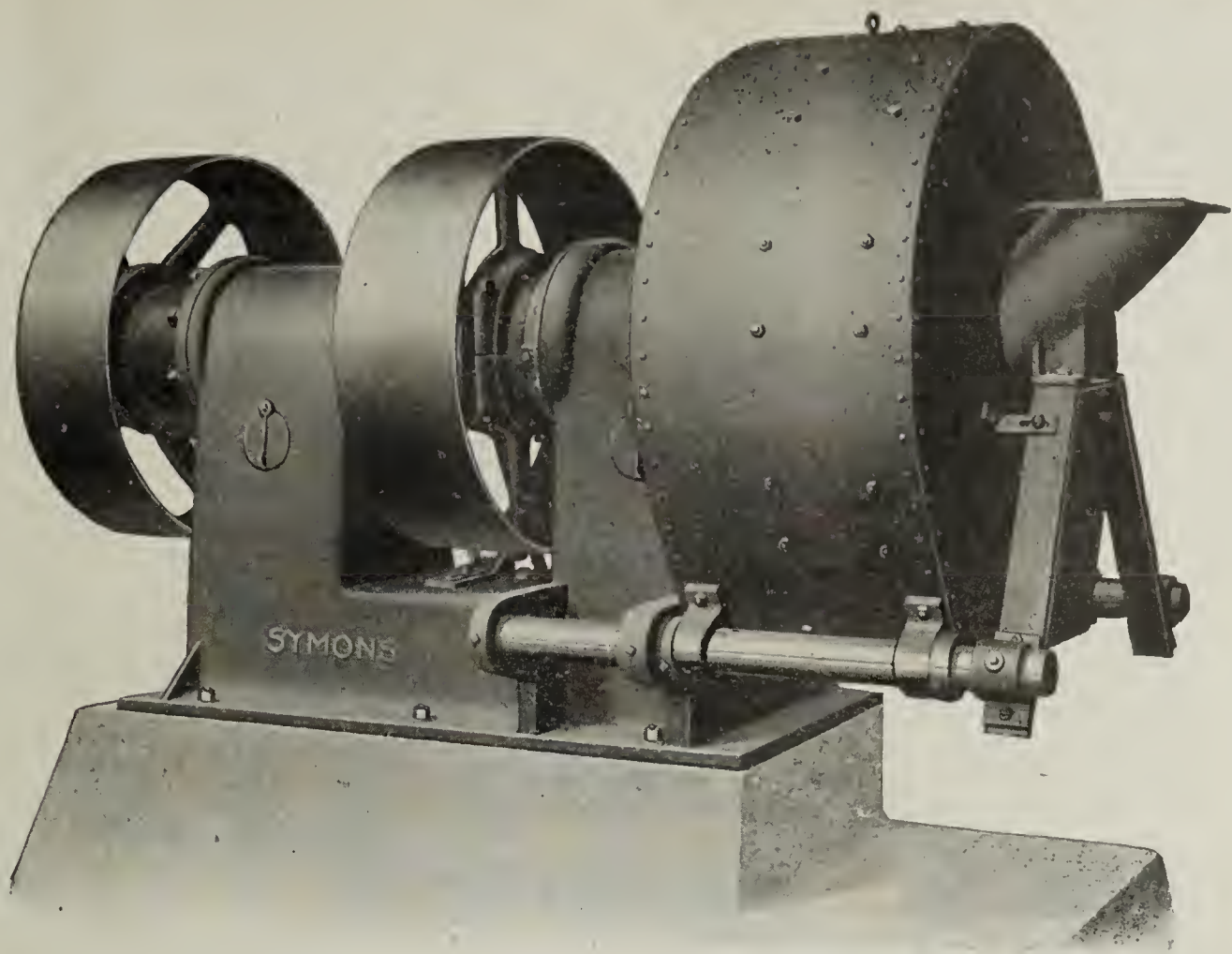
"We own over seventy-five patents pertaining to crushing and pulverizing machinery and related devices, and have a large number of applications pending in the Patent Office involving our recent improvements. It is not only our intention to keep ahead of the procession, but after we have secured protection for our various inventions which have placed our machines in a class by themselves, it is also our intention to enforce our rights as secured to us by our letters patent. Manufacturers and users are therefore notified that we shall institute proceedings against infringers of our patent rights. When you buy from us you not only get the best machine on the market, but we guarantee you against suits for infringement.

"Should anyone attempt to copy our Hinged Hammer principle, the buyers of said machines are purchasing an imitation and not getting the original and



Sectional View of Sturtevant Ring Roll Mill.

Here's the Crusher For Making that Small Sized Product!



THE SYMONS DISC CRUSHER

THE FIRST IMPORTANT QUESTIONS ARE: 1. What will it crush? 2. What capacity per hour? 3. How large is the receiving opening? 4. What horsepower is required? 5. What sizes of product? 6. Shipping weight?

OUR ANSWER: These machines are now crushing trap rock, gravel, boulders, granite, various kinds of ore and limestone in many parts of the United States, in Canada and England, as shown conservatively in the following table:—

TABLE OF WEIGHTS AND CAPACITIES FOR SYMONS DISC CRUSHERS

Size of Crusher.....	48-in.	36-in.	24-in.	18-in.	13-in.
Approx. Shipping Wt.....	30,000	19,000	8,500	5,600	3,000
Opening in Elliptical Feed Spout	11½ x 17	9½ x 14½	7 x 10½	4½ x 7	4 x 4½
Opening between discs at feed spout	8-in.	5-in.	3½-in.	2½-in.	1½-in.
Min. exit opening for best results	1-in.	¾-in.	½-in.	⅜-in.	¼-in.
	Size of Ring Tons per Hour	Size of Ring Tons per Hour	Size of Ring Tons per Hour	Size of Ring Tons per Hour	Size of Ring Tons per Hour
Cap. in tons per hour.....	1 = 45-60 1½ = 60-75 2 = 75-80 2½ = 85-100	¾ = 25-30 1 = 30-40 1½ = 40-50 2 = 50-60	½ = 12-15 ¾ = 18-20 1 = 20-25 1½ = 25-30	⅜ = 5-8 ½ = 8-10 ¾ = 10-12 1 = 12-15	¼ = 4-5 ⅜ = 5-7 ½ = 6-8 ¾ = 8-10
R. P. M. Main Pulley	100	133	150	200	300
R. P. M. Eccentric Pulley	200	266	400	450	600
Size of Pulleys	54 x 16	44 x 14	34 x 10	28 x 8	20 x 6
H. P. required	50-65	30-40	18-25	12-18	10-15

We stand back of these representations in the following manner —
Can you suggest a better way?

OUR PROPOSITION

We will ship to any responsible party one of these crushers to be promptly installed and operated, subject to a 20 day trial. If the CUSTOMER is not satisfied in every respect, he may return the machine to our factory without a dollar of payment to us.

Not a risky proposition to us,—for

THE SYMONS DISC CRUSHER MAKES GOOD.

Address **SYMONS BROS. CO.,** 605 Majestic Bldg., Milwaukee, Wis.

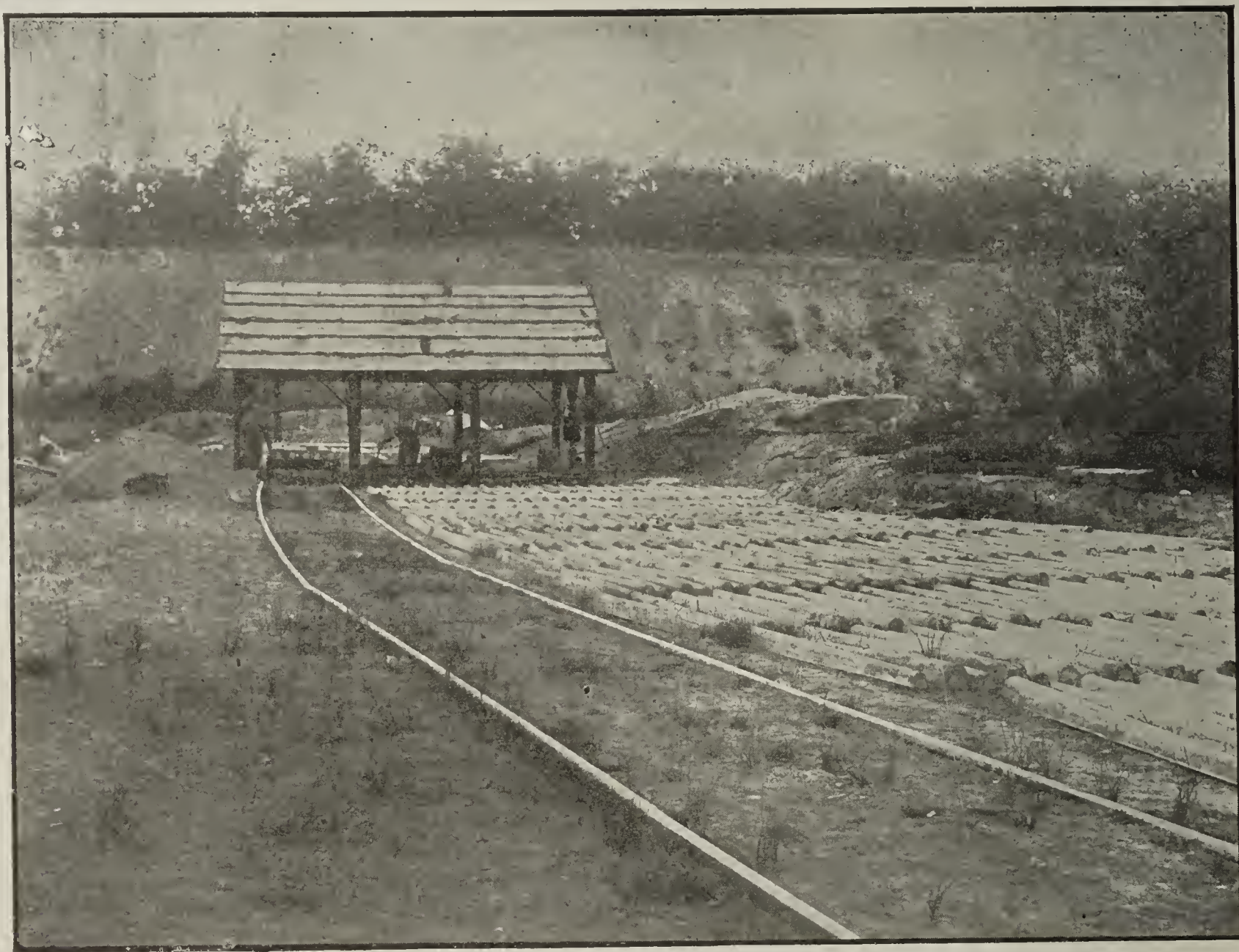
said machines offered for less, the buyer cannot possibly get the worth of his money for the following reason. That it is impossible for anyone to build a Hinged Hammer Crusher, Pulverizer, Granulator or Shredder with adjustable breaker plate, hammer, etc., without infringing some one of our patents on adjustments, and any grinding machine without having means for taking up the wear is not 100 cents upon the dollar, and not what the buyer should expect, and since our Company now have over 1700 of these machines upon the market in America and over 30 foreign countries, this fact alone should be a sufficient guarantee that our claims are backed up by actual facts and can be relied upon."

For further information kindly write to **Williams Patent Crusher & Pulverizer Company**, St. Louis, Mo., U. S. A.

THE USE OF REINFORCED CEMENT FENCE POSTS BY THE PENNSYLVANIA RY. SYSTEM.

While the Pennsylvania Railway System is probably not the first company that uses cement posts, it appears to be certain that the Pennsylvania railroad has made and is now using more reinforced cement fence posts along their lines in all parts of the East than any other company. This railroad is making cement posts at nearly a dozen points along its lines and supplies neighboring divisions with posts from these stations in order to have them experiment with them.

A typical plant of this kind is located at Warsaw, Ind., near Chicago, where a large number of posts has been made. Most of these have been set along the right of way near Warsaw. One of the principal reasons for selecting this location was the abundance of gravel to be found in the neighborhood. Sidetracks run di-



P. F. W. & C. Railway Company, "D. & A." Cement Post Plant, Warsaw, Ind.

Many thousand posts have been made at this plant, and several carloads have been sent to neighboring divisions. Several men are kept steadily making posts at this plant. The Pennsylvania System own and operate nearly a dozen "D. & A." Post Plants and are continually adding to their equipment.

NEWS ITEMS.

The Gandy Belting Co., Baltimore, Md., will erect a five-story steel and concrete addition, 50x87 feet, to its plant for general manufacturing purposes.

Alexander Baillie, Central Bldg., Seattle, Wash., western representative of the Balfour-Guthrie interests, which will erect a \$1,000,000 cement plant at Bellingham; states that machinery for the plant is now being purchased in the East.

Springfield Concrete Post Co., Springfield, Mo., announce an increase in capital from \$50,000 to \$200,000.

rectly into the gravel pits which are especially desirable on account of the conditions of moisture prevailing at this place, namely the bottom of the gravel pit is only about one foot above water level and, therefore, forms an ideal bed on which the moulded posts can be cured under the most favorable conditions. More over, the posts thus stored on moist soil for curing are protected on three sides by the inclines of the pit from the injurious effects of the wind.

The equipment used by the Pennsylvania Railroad in manufacturing cement fence posts is that of the D. & A. Post Mold Co., of Three Rivers, Mich., which consists of gang molds and a frame called "shaker" which supports the individual molds. The molds are

From the raw crushing department to stock house, all operations in the modern Cement Mill are made more simple and economical by Electric Motor Drive



WESTINGHOUSE motors and power equipment have proven most successful in producing these results in the Portland Cement Plant illustrated.

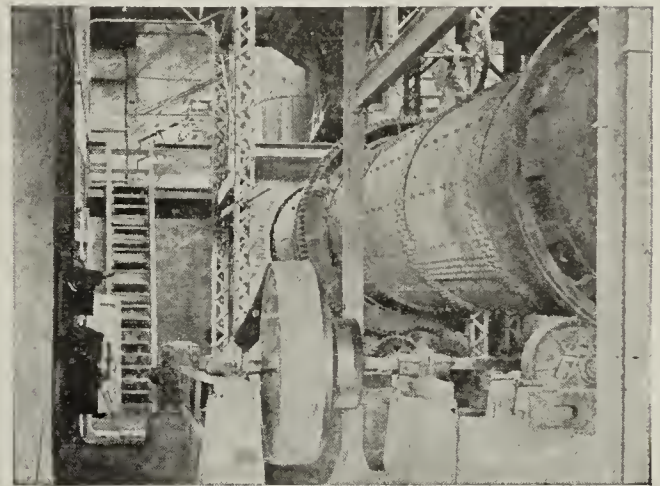
Twenty-seven hundred H. P. of Westinghouse Motors are used for the drive of machinery in all departments, assuring success by the exactness of design to meet the operating conditions. The motors for the heavier types of machines have large starting torque. Dust proof bearings are provided and special care given the mechanical and insulating properties of the coils. Special types of motors, such as the vertical type for the Fuller Mills and slow speed motors for the Tube Mills have been developed and the requirements of every department properly provided for by suitable motor equipment and method of drive.

On request, your Cement Mill propositions will receive a thorough analysis by experienced engineers of the Westinghouse Co. Refer to nearest District office; ask them to send you Section 3073 of Catalogue 3002-A.

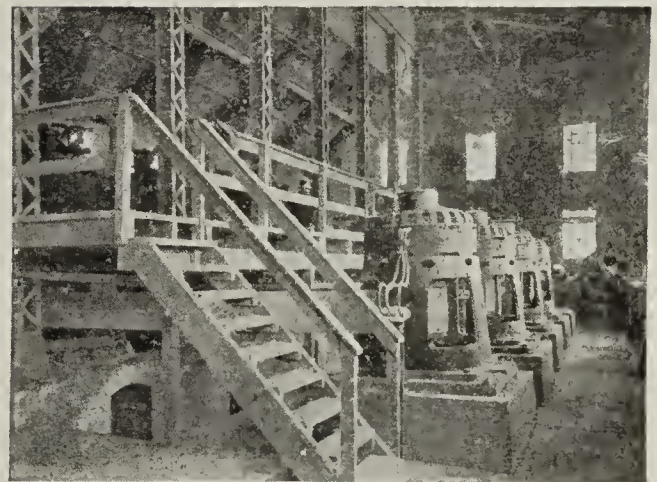
Westinghouse Electric & Mfg. Co.
EAST PITTSBURG, PA.

Atlanta	Boston	Chicago	Cleveland	Denver	Kansas City
Baltimore	Buffalo	Cincinnati	Dallas	Detroit	Los Angeles
New Orleans	Philadelphia	St. Louis	Salt Lake City	San Francisco	
New York	Pittsburg	Seattle			

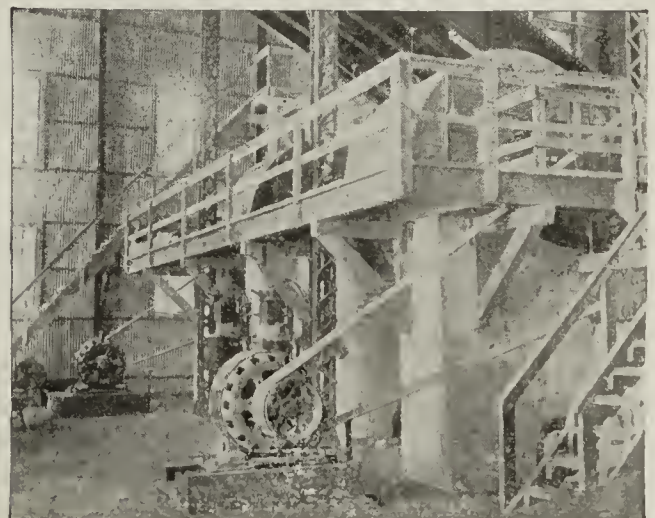
Cuba: Charles H. Thrall & Co., Havana.
Westinghouse Electric & Mfg. Co., of Texas, Dallas, and El Paso, Texas
Canada: Canadian Westinghouse Co., Ltd., Hamilton, Ont.
Mexico: Compania Ingeniera, Importadora y Constratista, S. A.
(Successors to G. & O. Braniff and Company). City of Mexico.



50 H. P. Westinghouse Motor Driving Kiln Dryer



75 H. P. Westinghouse Motors Driving Fuller Mills



50 H.-P. Westinghouse Motors Driving Raw Dept. Machinery

"U" shaped in cross section and turn out a post with a round back and flat face, thus no corners or crevices need filling in the molding; neither are there projections or holes through the posts nor corrugations, which all would weaken the post. No staples or fence fastening devices are inserted in the post while being molded, though they can be easily placed if desired. The wire cloth is fastened to the post by means of short pieces of wire called "tie wires" which surround the post, the wire cloth touching the flat face of the post. A clever tool, called "twister," serves to accomplish this object. The cost of doing this work is remarkably low.

For reinforcing, hoop steel is recommended by the manufacturers and also used at the plants of the Pennsylvania Road. It presents large surfaces for bond and is easily and quickly placed near the surface of the concrete where it imparts the greatest strength to the post. The open face of the molds makes possible the use of any kind or style of reinforcement, for instance plain or two-ply cable wire and corrugated or twisted steel bars of any description.

CEMENT MILL NEWS.

The Hecla cement plant at Bay City, Mich., which, it was announced some time ago, would be abandoned, have resumed operations with a reduced force, after a suspension since late in December last. Operations will continue, Superintendent Beck said, until the present supply of material is exhausted. The company employed 150 men at the time of the shut-down last winter, when it was announced that an unprofitable market had made continuance out of the question. A smaller crew will be put on, fewer laborers being required because of the elimination of night work in all departments save the kilns. The force will be added to, however, as rapidly as conditions warrant.

W. W. Poole manager of the Riverside Portland Cement Company says that his company has spent thousands of dollars recently at their plant at Riverside, California for the equipping of their plant with the Cottrell Electrical process of dust collecting. They have installed one unit of the system so far and will put in the others as fast as the apparatus can be pro-



"D. & A." Posts Made, and Fence Erected by the P. F. W. & C. Railway Company at Warshaw, Ind.

A permanent fence; neat in appearance. Concrete Posts are adaptable to any kind or style of fencing, and cost no more than short lived wooden posts.

The "Shaking" for settling the concrete used by this system is novel, giving the post a very smooth dense surface as if it was trowelled, which makes it practically impregnable to the action of the elements and preserves the reinforcement to a maximum degree. Further facts and suggestions are given in "Concrete Posts And How To Make Them", a fully illustrated booklet published by the D. & A. Post Mold Co., Three Rivers, Mich. This publication will be sent free upon request.

The Charlotte Plaster Company, of Charlotte, N. C., will rebuild their plant which was recently burned. They will install new machinery and, operate exclusively by electricity.

The Neeley Cement Block & Construction Company has been incorporated at Cortez, Colo., with a capital stock of \$25,000.00. The incorporators are Wm. G. and Wm. C. Neeley and Chas. R. Reed.

The Peoria Washed Sand & Gravel Co., Peoria, Ill., has increased its capital stock from \$5,000 to \$25,000.

cured. He says they have bought up considerable of the land adjacent to their factory and are trying in every possible manner to adjust difficulties arising from complaints of orange growers.

The Acme Cement Plaster company's mill and warehouse at Cement, Okla., was destroyed by fire starting from a spark from the smokestack of the power plant. The company will rebuild as soon as possible.

The Atlas Portland Cement company is preparing to re-open plant No. 5 at Ilasco, Mo. This means practically the doubling of the present force in every department. Superintendent Baker stated that he expected the force of the plant to be increased by 500 men. This plant was closed the first of the year and since that time has been undergoing repairs. No. 5 is a complete factory within itself and is a duplicate of the one at Hannibal. When the plant is re-opened the company will be operating a full force in nearly all departments, thus increasing their capacity.

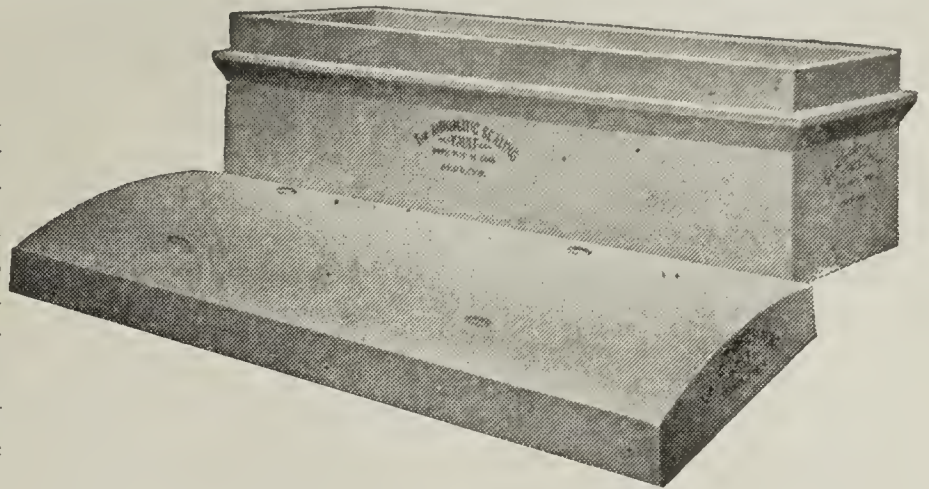
A Plain Talk to Concrete Men

About a Profitable Business

Concrete Burial Vaults.

Mr. Concrete Contractor:—Don't be prejudiced—don't think that the vault business means peddling vaults for funerals. You can manufacture concrete vaults in your plant and sell them to the undertaker, just as you sell blocks to a contractor. You can manufacture vaults as an independent business, selling your output to the undertaker, or you can run the business as a sideline to your present plant, keeping your force busy in dull season.

Concrete burial vaults are without competition. They are in demand. They sell at a good price. You make three times the profit on them that you do on other products.

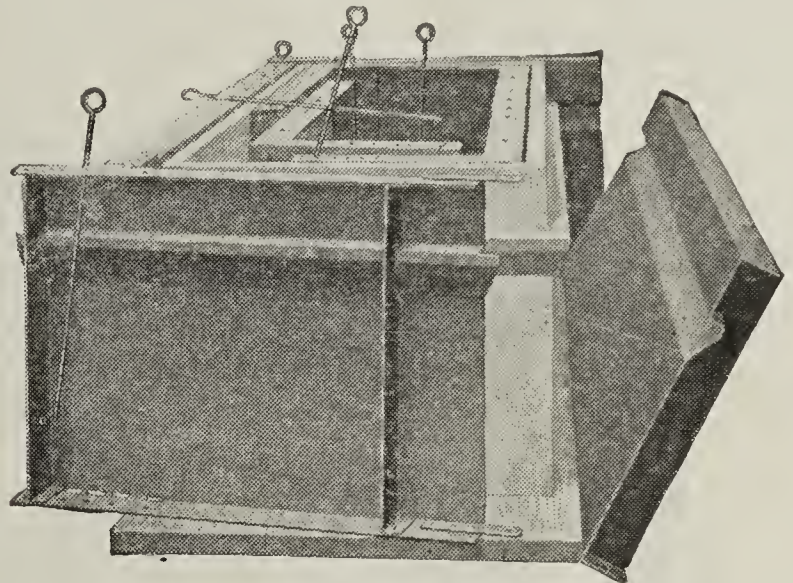


Automatic Sealing Vault. Note the pleasing proportions and beauty of design.

The Automatic Sealing Vault.

Our vault was invented by a practical undertaker. It is medium weight, steel-reinforced, waterproof, ghoul-proof, sanitary. It is made in two pieces. The lid is sealed automatically in the grave. No other vault can compete with it.

Our Bessemer steel mold is adjustable. Seven sizes of vaults are made on one mold. The molding surfaces are without rivets or other unevenness, casting a smooth, clean vault. You don't have to buy a big equipment—this one mold does it all. You can make a complete vault every day.



Removing adjustable mold from completed vault in 12 hours. Note the clean-cut outline.

Profitable Investment.

You can readily see from the amount of material which is required to build our Automatic Sealing Vault, that there is no other line of cement work that affords the large profit which is derived from vault manufacturing.

It takes 6 cubic feet of cement.

12 cubic feet of sand.

15 lbs. reinforcing material.

3 lbs. of water-proofing.

8 hours labor to make a standard size vault.

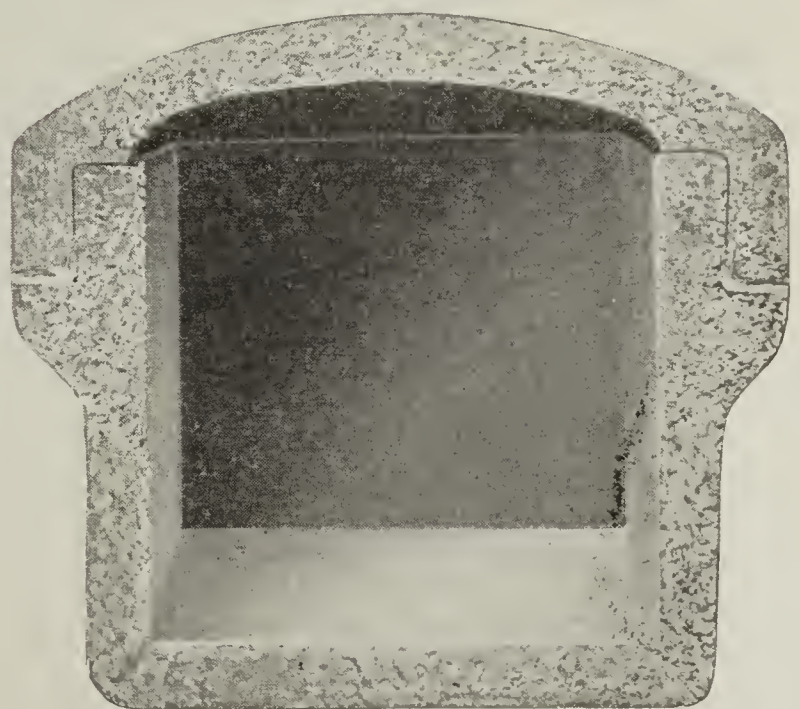
Total cost of above \$5.70.

The manufacturer gets from \$25.00 to \$30.00 and the undertaker retails them from \$40.00 to \$50.00.

Our big book tells all about it. Write us today.

FREE BOOK ABOUT VAULT MANUFACTURE.

This book tells about the vault, the mold, the reinforcement, how to make vaults; the exact cost of manufacture; the sales price; how to sell vaults, etc. Ask for a copy, mentioning this advertisement in Cement and Engineering News.



Cross-section of vault, showing method of placing lid onto the vault that makes it absolutely waterproof on account of the air pressure.

The Automatic Sealing Vault Co.

PERU, INDIANA

NEW CEMENT MILLS.

The safety Board of St. John, N. B., have been asked to consider a proposition from Wm. N. Beach, president of the Pennsylvania Cement company, 26 Cortland St., New York, N. Y., in regard to the erection of a cement plant at that place to cost about \$500,000.

The Associated Portland Cement Manufacturers, 72 Fenchurch St., London, England, have announced that plans are being prepared for the expenditure of \$1,000,000 for mills to have a capacity of 7,000 barrels of cement per day to be erected at Nelson, British Columbia, Canada.

With a force of nearly 1,000 employes, a payroll of \$18,000 per month or \$216,000 annually and a plant representing an investment of five million dollars, the Iowa Portland Cement company is undoubtedly the largest manufacturing concern in the city of Des Moines.

Nearly two and one half million sacks of cement are manufactured annually in the plant in Des Moines near Valley Junction, says the Des Moines Register. The average daily capacity of the huge factory is 2,000 barrels or 8,000 sacks of cement. The company devotes its efforts exclusively to the manufacture of Portland cement.

Press reports state that the Universal Portland Cement company of Chicago will build a cement plant in Duluth, Minn., adjoining the Minnesota Steel company's plant, to have a daily capacity of 4,000 bbls. The Great Northern Power company is now negotiating with the Universal Company for the supplying of 4,000 horsepower.

The Iowa Portland Cement Company's plant is one of the most up to date factories in the county in point of machinery equipment. It was established two years ago and is equipped with the most modern cement making apparatus.

George E. Nicholson is president of the company. L. F. Crofoot is vice president, and J. C. Smith, secretary and treasurer.

J. H. Holbrook of Portsmouth, O., engineer for the Empire Portland Cement company, is in Menominee, Mich., It is his concern which it is announced will erect a large factory in that city. Mr. Holbrook states that he is there to "break ground" for the plant and that during the next ten days he will have a crew of men busy at the site, laying out the lines and doing other preliminary work. Actual construction work will start in June. The main building is to be 440 feet long and 369 feet wide. There are to be four dry kilns 125 feet long and 8 feet wide and two dryers 60 feet long and 6 feet wide. The building will be one story in height and of reinforced concrete.

W. H. Cottengin, mayor of Pine Hill, Kentucky, advises us that Mr. J. A. August of Washington, D. C., has sold his property in Pine Hill to the Freeborn Engineering and Construction Company of Kansas City, Mo., and they propose to build a cement plant soon.

LINK BELT CO.

Bulletin No. 108 of the Link Belt Co., illustrates the Flint-Rim Sprocket and Traction Wheels, Flint-Rim Rollers, Flint-Rim Crusher Rolls which represent the most durable machinery on the market for the handling of cement materials.

A COMPLETE TILE PLANT For \$765⁰⁰

AT last you have an opportunity to start a cement drain tile factory with but a small investment. You can now buy a Schenk Cement Drain Tile Machine with complete equipment for making 4, 5, 6, 8, 10 and 12" tile along with a No. 1 Perfection Mixer and S. & S. Gasoline Engine and all the shafting, belting, hangers, pulleys, etc. necessary to run the plant for the exceedingly low price of \$765.00.

If you have a thousand dollars that you can possibly invest, here is your opportunity to make from 30 to 100% the very first year. In every state, in every county, in every township and in every town, there is demand for cement drain tile and although Schenk Machines this season will make more than 140,000,000 there seems to be a need for a greater distribution of factories.

REALIZING this we are making this most ridiculous low price in order that we may introduce cement drain tile in every community. If you are in the concrete business, make this addition to your plant and put in a tile machine, mixer, engine and make cement drain tile.

Don't put the matter off for this offer is only good for the next sixty days and we will positively not take a single order at this price after July 31st.

Complete details regarding selling plans with full description of equipment, etc. has been prepared and is awaiting your instructions, so get busy at once, sending us your name and address and we will immediately put you in possession of full particulars regarding our proposition which means a complete cement drain tile plant for \$765.00. Don't forget to mention this publication.

THE CEMENT TILE MACHINERY CO., 1150-60 Rath St., WATERLOO, IOWA

CEMENT

... AND ...

ENGINEERING NEWS



Mrs. Robert Stafford's Estate, Huntington, L. I. Exterior Finish
Medusa White Portland Cement and Granulated Marble.

LIONEL MOSES, Architect.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

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CHICAGO, JULY, 1911

CRUSHED STONE, SAND AND GRAVEL.

The large demand for crushed stone, sand and gravel used in the manufacture of concrete has rapidly raised the value of these formerly unimportant materials and has made their exploitation and preparation for the market an art requiring almost as much skill as the manufacture of cement itself.

For instance, a modern crushed stone plant of fair size contains fully as much machinery and labor-saving devices as a large Portland cement plant. Economical handling of the materials necessitates a layout of the plant on the largest possible proportions and machinery of the best workmanship, crushing, elevating and conveying machinery being the main part of the equipment outside of power plant and electric installation.

The capital invested in stone quarries, sand and gravel pits on the outskirts of our large cities and the profits made in this industry fall little short of the figures to which we are accustomed from the cement industry.

And yet the industry is still in its infancy, as rumors indicate to the effect that a large Eastern firm, which is doing everything on a gigantic scale, contemplates invading the Chicago market in the near future.

Although the materials have to undergo only crushing, screening and washing processes, close attention to all details is as important as in other industries requiring more elaborate treatment. Moreover, a careful study of transportation facilities and hauling of the materials to the job has to precede the erection of a plant. Every cent saved per cubic yard in any of the various manipulations of preparing for the market and shipping amounts to a great deal when summed up, as the quantities of crushed stone, sand and gravel annually consumed in the United States represent an enormous figure, namely about ten times as much as the seventy-five million barrels of cement with which they are made into concrete.

SAND-LIME PRODUCTS.

By E. Leduc & Ch. de la Roche.

Disastrous Effect of the Use of Lime Improperly Hydrated:

The main point to be considered in selecting a suitable lime for the manufacture of sand-lime products is that it is completely hydrated, that is to say, does not contain unslaked particles which would cause trouble in the future through expansion.

The burnt lime which, upon leaving the lime-kiln, forms large blocks, is sprinkled with water which causes it to disintegrate and to hydrate. This process of hydration is accompanied by a considerable increase of volume. The expansive force is so great that a clay brick containing a piece of lime of nut size is broken by the increase of volume of the lime, if the brick is submerged in water.

If insufficiently hydrated lime is used in the manufacture of sand-lime products, the raw brick do not look different from the regular product; however, after having been subjected to the hardening process, the brick are found to be fissured and to have increased in volume by swelling. This change results simply from the sudden hydration of the lime in the presence of steam under high pressure. The process of expansion within the hardening brick is naturally accompanied by disastrous results.

The only way to prevent this is to make use of lime which was previously sufficiently hydrated.

Stale or Partly Carbonated Lime: It is equally important to make use of a hydrated lime that has not been partly carbonated through exposure to the air.

Chemical analysis of some kinds of hydrated lime entering the process of manufacture reveals at times as much as 33 per cent of calcium carbonate. It is obvious that similar lime is unsuitable for the manufacture of sand-lime products, as the hardening is due to calcium silicate forming between the hydrated lime and the silica of the sand. The calcium carbonate, however, acts the part of an inert body; it dilutes the mixture and prevents chemical reaction between hydrated lime and sand to go on properly. Moreover, it decreases the proportion of the active lime to such an extent that a sand-lime mixture made with a hydrated lime containing 33 per cent of calcium carbonate contains only 6.66 per cent of hydrated lime instead of the 10 per cent that it is supposed to contain, which alters the conditions of manufacture considerably.

A great number of failures in the manufacture of sand-lime products have been traced back to the application of partly carbonated or stale lime.

True to the principles underlying our working plan, we tried to prove also the effect of stale lime by experiment. With that view, we made two series of tests, the first with a pure lime which was carefully and completely slaked, and the second with the same hydrated lime after it had been exposed to the air for four days.

Table XVIII shows the results. All test pieces made with pure hydrated lime have given considerably higher figures than those made with hydrated lime which was partly carbonated.

The Fineness of the Lime: According to the method of slaking the lime, the resulting hydrated lime is more or less fine. A brief deliberation shows that the finished sand-lime products must be the stronger, because the ingredients are more uniformly distributed, the finer the hydrated lime was, assuming in each instance equal proportions of lime, of course.

Table XIX illustrates the aforesaid by a comparison of the results obtained with the same hydrated lime of two different degrees of fineness; the first was sifted through a 200-mesh sieve, while the second was not sifted.

TABLE XVIII:
EFFECT OF THE APPLICATION OF STALE LIME.

Quality of Lime	Lime percent	Sand percent	Initial Compression of mixture lbs.	Steam Pressure lbs.	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs. per sq. in.				Average.
Pure Hydrated Lime	8	92	3.750	120	6	1.650	1.688	1.650	1.725	1.677
	10	90	"	"	"	2.100	2.025	1.950	2.025	2.025
	12	88	"	"	"	1.987	2.100	1.987	1.950	2.006
	8	92	7.500	"	"	2.137	2.100	2.100	2.250	2.146
	10	90	"	"	"	2.437	2.512	2.250	2.625	2.455
	12	88	"	"	"	2.588	2.625	2.700	2.550	2.614
Hydrated Lime Partly Carbonated	8	92	3.750	"	"	.825	1.275	1.275	1.275	1.088
	10	90	"	"	"	1.500	1.575	1.538	1.388	1.515
	12	88	"	"	"	1.688	1.688	1.500	1.425	1.575
	8	92	7.500	"	"	1.575	1.500	1.575	1.538	1.546
	10	90	"	"	"	1.838	1.763	1.763	1.725	1.772
	12	88	"	"	"	1.988	1.950	1.912	2.100	1.988



View of Sand Lime Brick Plant at Melbourne, Australia, Built by the International Sand Lime Brick & Machinery Co., New York.

TABLE XXI.
RESULT OF MORE OR LESS PERFECT MIXING OF THE MATERIALS.

Method of Mixing.	Lime percent	Sand percent	Initial Compression of Mixture lbs.	Steam Pressure lbs.	Time of Exposure to Steam. hours	Resistance to Compression after hardening in lbs. per sq. in.				Average.
Mixture Prepared Carefully	8	92	3.750	120	6	1.650	1.688	1.650	1.725	1.680
	10	90	"	"	"	2.100	2.025	1.950	2.025	2.025
	12	88	"	"	"	1.988	2.100	1.988	1.950	2.005
	8	92	7.550	"	"	2.138	2.100	2.100	2.250	2.145
	10	90	"	"	"	2.438	2.512	2.250	2.625	2.456
	12	88	"	"	"	2.588	2.625	2.700	2.550	2.615
Mixture Prepared in a Negligent Way.	8	92	3.750	"	"	1.275	1.500	1.312	1.275	1.340
	10	90	"	"	"	1.538	1.350	1.500	1.500	1.470
	12	88	"	"	"	1.312	1.500	1.462	1.575	1.480
	8	92	7.500	"	"	1.688	2.025	1.762	1.538	1.750
	10	90	"	"	"	2.850	2.212	1.500	1.650	1.865
	12	88	"	"	"	1.725	2.250	2.250	2.288	2.130

The results obtained with the finer grade of lime are all higher than those originating from the coarsely ground hydrated lime.

Selection of the Lime: The selection of the best hydrated lime is one of the most important points that has to be decided before erecting a sand-lime brick plant.

A few carefully conducted experiments with the available sand and various grades of lime obtainable in the vicinity of the proposed plant will soon teach which are the best materials.

Thus, for instance, seven kinds of lime of different origin, had to be examined prior to the erection of a certain plant.

With each kind of lime four sand mixtures were prepared which contained 8 per cent, 10 per cent, 12 per cent and 14 per cent of hydrated lime. The sand-lime mixtures were compressed at 4,500 pounds per square inch, which corresponded with the pressure of a 75-ton brick press. The steam pressure amounted to 120 pounds and the time of hardening was 8 hours.

The strength of the test cylinders was determined the following day (see table XX).

From the figures recorded in Table XX it is easy to see that lime "C" has given the best results, as it possessed the highest strength in a sand lime mixture containing 10 per cent of hydrated lime, a percentage which



HOTEL RUDOLPH, ATLANTIC CITY, N. J.

Silica Brick, Made by the "Division Method" for Fireplaces and Mantels.

The samples were marked:

- A. Pure lime, crushed.
- B. Lime, slightly hydraulic, crushed.
- C. Pure lime, large blocks.
- D. Lime, slightly hydraulic, hydrated.
- E. Pure lime, large blocks.
- F. Lime.
- G. Pure lime.

Chemical analysis proved these limes to have the following composition:

	A.	B.	D.	E.
Silica	3.07	6.73	4.96	0.78
Alumina	1.78	2.07	1.96	0.84
Iron Oxide.....	0.62	1.01	0.79	0.16
Calcium Oxide....	68.53	68.34	65.74	69.50
Magnesia	1.16	1.54	1.42	0.42
Loss at red heat...	24.84	20.18	25.25	28.52

100.10% 100.27% 100.31% 100.22%

As the hydraulic limes were found to increase in volume when moistened with water, they were thoroughly hydrated before use. But even after four weeks lime "F" was found to be still unsound; for this reason it was rejected.

should not be exceeded for economical reasons.

The Treatment of the Sand-Lime Mixture.

Perfect Mixing of Sand and Lime a Necessity: Small lumps of lime can sometimes be discovered on the surface of sand-lime brick or in the interior of it; they are due to imperfect mixing of sand and lime, which gives rise to numerous defects of the finished product:

1. Calcium silicate, the substance which cements the sand grains together can be formed only where sand and lime are uniformly distributed. Thus, it is obvious that a sand-lime mixture, which contains 50 per cent of the hydrated lime in form of lumps (a state in which, at many factories, the sand-lime mixture is seen to enter the brick press), does really contain only 5 per cent, instead of 10 per cent, of lime in contact with silica, while the remainder is inactive. This, of course, is of the greatest consequence upon the quality of the brick. The small admixture of 10 per cent of hydrated lime to 90 per cent of sand can reasonably be expected to yield a good product only, if the ingredients have been mixed very thoroughly.

2. If lime is used which is not perfectly hydrated, the expansive force of the hydrating lime particles will

TABLE XIX.

SAND-LIME MIXTURES WITH HYDRATED LIME OF DIFFERENT DEGREES OF FINENESS.

Quality of Lime.	Lime percent	Sand percent	Initial Compression of Mixture. lbs.	Steam Pressure lbs.	Time of Exposure to Steam. hours	Resistance to Compression after Hardening in lbs. per sq. in.				Average.
Hydrated Lime Sifted	8	92	3.750	120	6	1.650	1.688	1.650	1.725	1.680
	10	90	"	"	"	2.100	2.025	1.950	2.025	2.025
	12	88	"	"	"	1.987	2.100	1.987	1.950	2.005
	8	92	7.500	"	"	2.137	2.100	2.100	2.250	2.145
	10	90	"	"	"	2.437	2.512	2.250	2.625	2.456
	12	88	"	"	"	2.587	2.625	2.700	2.550	2.615
Hydrated Lime Unsifted	8	92	3.750	"	"	1.313	1.350	1.388	1.313	1.340
	10	90	"	"	"	1.500	1.538	1.500	1.575	1.530
	12	88	"	"	"	1.762	2.550	1.950	1.875	1.845
	8	92	7.500	"	"	1.800	1.725	1.725	1.725	1.742
	10	90	"	"	"	1.800	1.725	1.950	1.800	1.818
	12	88	"	"	"	1.950	2.063	2.138	2.175	2.080

TABLE XX.

RESULTS OBTAINED WITH VARIOUS GRADES OF LIME.

Lime Used.	Water in Sand-Lime Mixture percent	Lime percent	Sand percent	Resistance to Compression after Hardening in lbs. per sq. in.				Average.
A Pure Lime	11	8	92	—	—	—	—	—
	11	10	90	1.350	1.650	1.575	1.350	1.480
	13	12	88	1.912	1.950	1.988	1.875	1.932
	13	14	86	1.837	2.025	2.025	2.025	1.980
B Hydraulic Lime	6	8	92	1.200	1.162	1.125	1.162	1.162
	6	10	90	1.275	1.238	1.275	1.200	1.245
	6	12	88	1.350	1.350	1.350	1.350	1.350
	6	14	86	1.800	1.688	1.650	1.650	1.695
C Pure Lime	11	8	92	2.325	2.250	2.212	2.212	2.250
	12	10	90	2.438	2.588	2.512	2.550	2.520
	13	12	88	2.475	2.700	2.625	2.662	2.615
	13	14	86	2.700	2.550	2.512	2.550	2.580
D Hydraulic Lime	6	8	92	938	1.012	976	975	972
	6	10	90	1.275	1.238	1.238	1.238	1.245
	6	12	88	1.462	1.425	1.425	1.462	1.443
	6	14	86	1.650	1.688	1.650	1.650	1.658
E Pure Lime	11	8	92	1.838	1.950	2.400	1.875	2.015
	12	10	90	—	—	—	—	—
	13	12	88	2.438	2.400	2.512	2.438	2.446
	13	14	86	2.662	2.700	2.625	2.662	2.662
G Pure Lime	11	8	92	2.138	1.988	1.950	1.950	2.005
	12	10	90	2.062	2.212	2.025	2.100	2.100
	13	12	88	2.212	2.025	2.062	2.138	2.108
	13	14	86	1.838	2.138	2.138	2.175	2.070

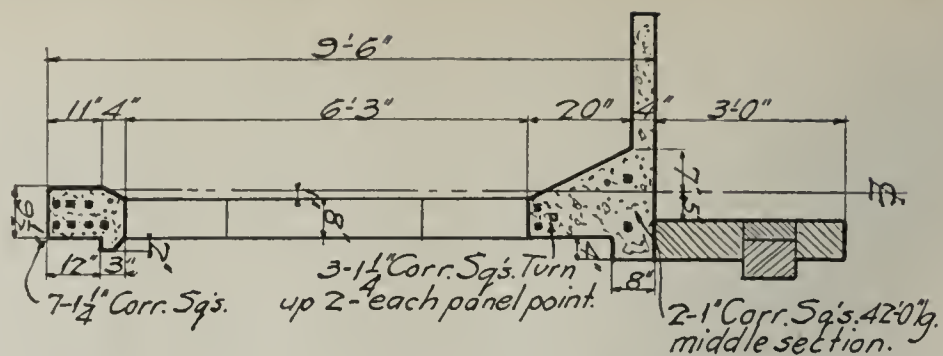
not become noticeable, if they are finely pulverized and uniformly distributed throughout the mass, whereas, the same imperfectly hydrated lime may give rise to swelling of the brick, if the lime occurs in lumps.

Imperfect mixing of the materials yields a porous hollow-sounding brick of inferior strength and low resistance to freezing.

For the purpose of demonstrating the effect of more or less careful mixing upon the strength of the finished product, we prepared two series of test pieces, of which one was mixed very thoroughly in the usual manner, while the other was mixed in a superficial way. The results are recorded in Table XXI.

These tests show plainly the importance of perfect mixing which is one of the most necessary points in the manufacture of sand-lime products.

(To be continued.)



Section of 80-foot Girder at Temporary End of Building.

room for the support of the crane rail. This unusual construction was adopted as the ultimate solution of the problem of constructing a reinforced concrete building for warehouse purposes which may, at some time in the future, be changed over into an ordinary factory building. The entire design was perfected with an eye to this development and the future introduction of the usual concrete column and beam



APARTMENT HOUSE, GLEN FALLS, N. Y.
Faced With Sand Lime Brick Made by the "Division Method."

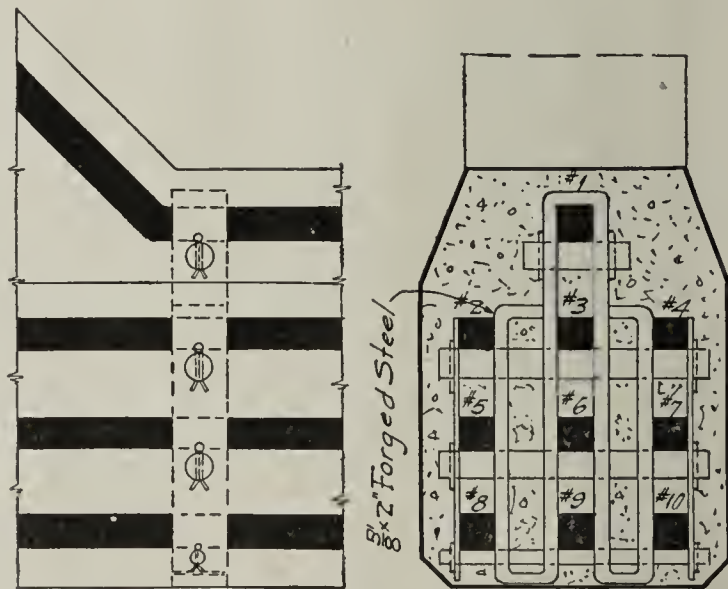
AN EIGHTY FOOT CONCRETE GIRDER.

A reinforced concrete warehouse which has recently been completed for the Hood Rubber Co., at East Watertown, Mass., contains a feature of design which is unusual from several points of view. This is a set of reinforced concrete roof girders which have a clear span of 80ft. These immense girders span the crude storage room which has a height of four stories and is designed to be served by a crane loading and unloading the stored rubber on any of the various floors of the manufacturing section of the building. Along one side of the storage room are galleries on the second and third floor levels in which machine work will be done. At the end of the room the three floors of the manufacturing section open directly into the store room like the galleries, but these floors are stepped back one bay so that the crane may easily serve any floor.

The store room is 180 ft. long x 80 ft. wide, and by reason of the roof girders contains no columns whatever. The girders are 9' 6" in depth with a web 8" thick, and are designed to carry a flat concrete roof. Just below these trusses are a set of brackets formed on the concrete columns on either side of the store

construction or mushroom floor construction throughout what is now the store room.

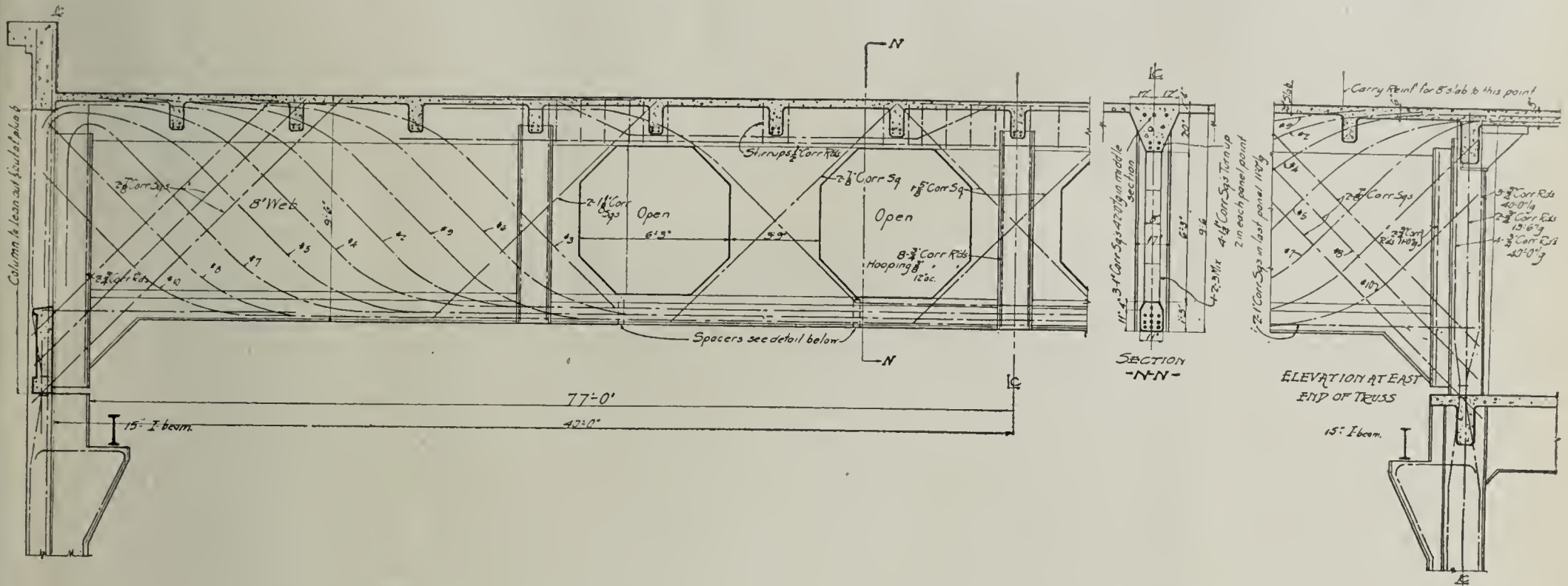
Another future possibility which had to be considered in deciding upon the design was the addition of one, two or three more stories. In case these changes



Detail Showing Spacer to Hold Steel Bars in Position in 80-foot Girder.

are made a minimum of concrete need be removed from the girders to provide for columns and it is expected that the store room may be transformed into an ordinary factory building at a minimum cost. What is now the flat concrete roof would become in case of any addition to the present height of the building, the

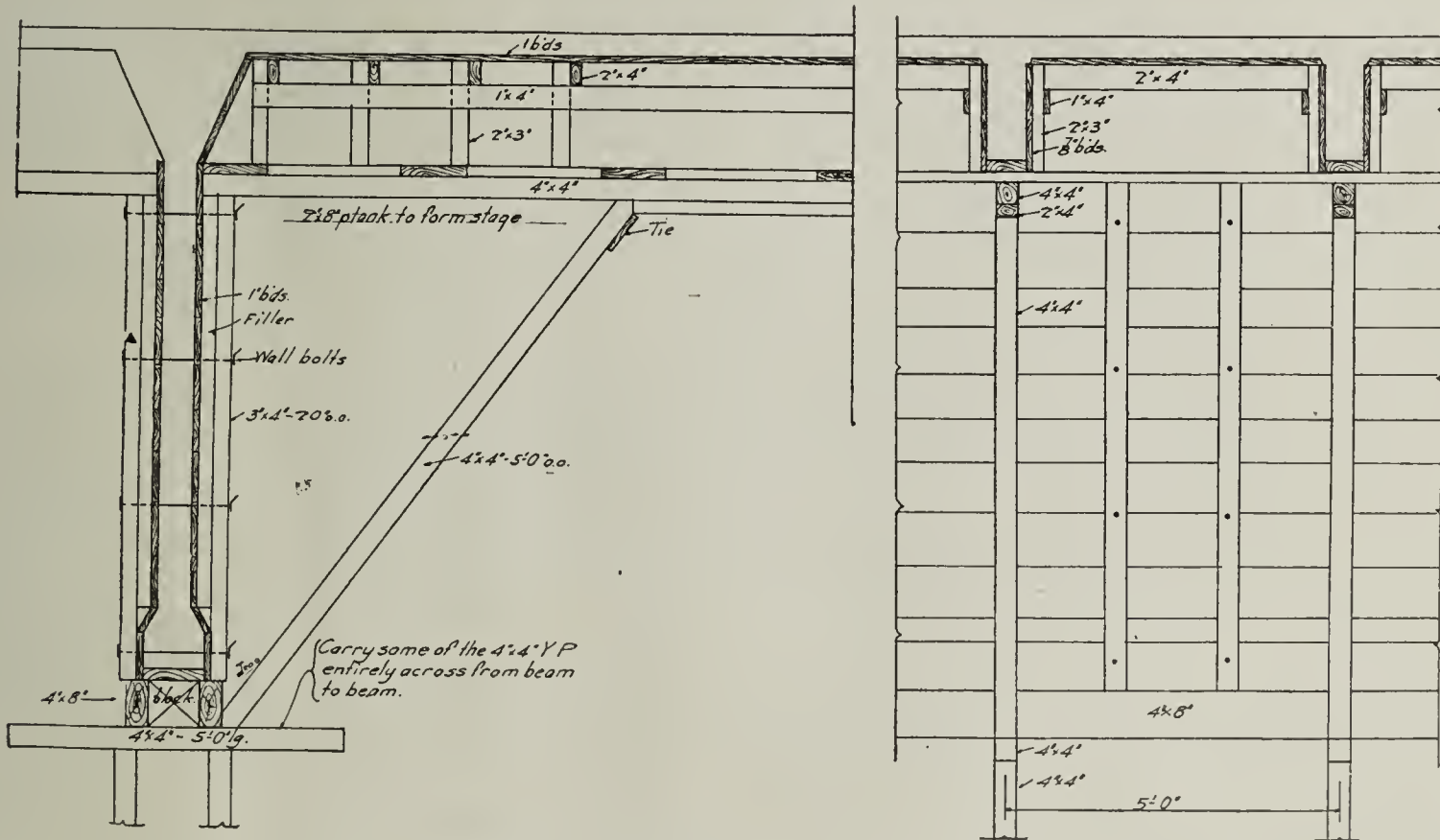
the rolling mill to get out these unusually lengthy reinforcing bars. The main tension reinforcement of these girders consists of ten $1\frac{1}{4}$ " square bars arranged as shown in the detail. For the diagonal reinforcement $\frac{5}{8}$ " corrugated square bars arranged in pairs on either side of the center were used. Between



Side Elevation and Cross Section of 80-foot Girder at Hood Rubber Co.'s Warehouse.

fourth floor. The 80' girders support 7" x 18" longitudinal stringers which are set 5' on centers and carry the 4" flat concrete roof slab. The reinforcing for the long girders was designed by the designing engineer of the building, Mr. Henry F. Bryant, of Brookline, Mass., so that the stress should nowhere exceed 20,000 lbs. per square inch, and with the high carbon steel used it is confidently predicted that there will be

the center and either end the diagonal reinforcement consists of $\frac{7}{8}$ " and $1\frac{1}{8}$ " square bars. The end shear is taken by three $\frac{7}{8}$ " square corrugated bars which are carried down diagonally as shown in the drawing. Four $1\frac{1}{4}$ " corrugated bars reinforce the roof stringers and the roof slab is reinforced by $\frac{3}{8}$ " corrugated bars set diagonally 6" on centers. One-half inch corrugated bars were used in making up the stirrups. Consider-



Section and Elevation of Centering Used on 80-foot Girder.

no serious deflection or stretch-cracks in spite of the unusual length of span. As will be seen by a glance at the accompanying drawing of the reinforcement, the tension steel bars used are unusually long, the majority being about 100' in length and $1\frac{1}{4}$ x $1\frac{1}{4}$ " in section. Special work was required on the part of

able saving in total weight of the trusses has been accomplished by leaving hexagonal openings at various points not subject to stress. This procedure in no way impaired the strength of the girders and at the same time made them considerably lighter. In the truss at the end of the building these spaces are util-

ized for windows. This truss carries a concrete block and brick cornice, and being the end girder its main tension reinforcement consists of seven instead of ten $1\frac{1}{4}$ " bars, the lower flange being cut away on the outside to provide for a sill.

Naturally, in casting such girders as these, which are the longest ever designed in New England, unusual care had to be observed. Particularly was this true because of the fact that the entire building operations took place in midwinter. Accordingly the contractors, The Aberthaw Construction Co., of Boston, Mass., observed particular caution in mixing the concrete and insuring it against freezing. For the latter purpose a combination of the two usual methods of protecting concrete in winter, that is, by raising the temperature of the concrete, and second by lowering its freezing point, was employed. A certain amount of salt was dissolved in the water used in order to lower the freezing point and at the same time, the different constituents of the aggregate were heated by means of steam pipes before going to the mixer. As an additional precaution, the temperature of the entire building was maintained at about 30 degrees above the outdoor temperature by enclosing the open spaces in the outer walls with sail cloth and burning coke in salamanders in various points in the structure. Holes were left in the forms at various points in the intermediate floors to insure the rising of warm air to the upper stories in the manufacturing section of the building.

Alongside the spur track on which the carloads of cement, stone and gravel were received, a steam pipe was run with tees at various points. Steam hose connected to these tees was carried into the bottom of each stone-filled car and thus the entire carload heated before going to the mixer. The sand which was dug on the premises after being screened was piled up over steam pipes laid on the ground and after being thoroughly warmed was carried to the mixer in a pit under the main floor at the center of the building. Rapid work in casting the girders was made possible by the use of industrial railway tracks laid on top of the forms on which ran dump cars from the head of the elevator to any desired point on the roof.

The method of centering the 80' girders and roof slabs employed was as follows: 4" x 4" vertical braces were carried from the floor to the roof with cross bracing to the girder forms. The latter were supported on 4" x 8" blocks carried on two 4" x 4" struts to the ground. Wooden shims were used for leveling up the main girder forms.

By pursuing the work through the cold weather it was possible for the contractors the Abertaw Construction Co., to turn over the completed building to the owners four or five months earlier than could possibly have been the case if building operations had been postponed until the arrival of warm weather. Henry F. Bryant of Brookline, Mass., was responsible for the entire design of this unique building and had general supervision of its erection.

The Consolidated Concrete Tie Co., Cairo, Ill., has been incorporated with \$100,000 capital to manufacture concrete ties under the Snedd and Cowan patents. The company has a plant in operation at the present time at Pulaski, Ill., and is having plans prepared for another to be erected at Cairo.

CEMENT AND ALKALI.

A. R. Beymer.

In regard to my experience with cement and clay tile in alkali, I have found that both kinds have proven worthless to stand alkali when not made in the proper manner, and I have known both kinds to stand for years in the strongest alkali seepage water when the right conditions existed in the tile. Of the two kinds I prefer the cement tile when made right to the clay tile. The cement tile put on the market the past few years by a great many of the cement stone works around the country were porous so the water would seep through the tile, and have proven worthless in alkali water. On the other hand cement tile that were made with a wet mixture and impervious to water were laid about ten years ago at Rocky Ford and about a year ago were dug up and these tile were harder and better by having been in the strong alkali water for nine years. These tile would be sound in a hundred years as far as the alkali was concerned. A clay tile must also be hard and impervious to water to stand alkali. I have seen clay tile slack away and go down in a short time. Four years ago I was engineer on a job at Rocky Ford, Colo., where we laid a concrete tile line, made on a special machine, 17 ft. under the surface of the ground in strong alkali water. The tile was 18-in., reinforced every 4 in. with a No. 10 wire hoop; the line was nearly a mile long. There has been for the last four years from two to four second-ft. of strong alkali water going through this tile and to date it shows no effect of the alkali whatever.

Tile to stand alkali must be made with a wet mixture, and when made should be wet enough so that when the molds are taken from the tile the water will show on the tile and also on the molds. Then the tile should be kept wet for several days after they are made. The test I use to determine the good tile from the poor ones is to turn the tile down, when dry on its side and turn a small, slow stream of water on the tile. If the water shows through on the inside of the tile after a few minutes the tile will not stand up in alkali water, but on the other hand if the water does not show through, the tile will stand all right.

AVOIDABLE DEFECTS IN CONCRETE BLOCKS.

When defects of weakness or porosity are found in concrete blocks, they may generally be attributed to one or more of the following causes: Poor quality of cement used; use of an insufficient quantity of cement; use of soft stone or soft stone screenings, very fine-grained or dirty sand, soft gravel or gravel coated with clay, frozen materials, impure or dirty water in the mixing; insufficient tamping; shaking or jarring of blocks before they are thoroughly hardened; insufficient moisture in curing; and too rapid drying.

Where the operation of block making is carried on in any considerable amount, the use of a mechanical tamper is recommended to insure uniform consistency and mechanical perfection in the block.

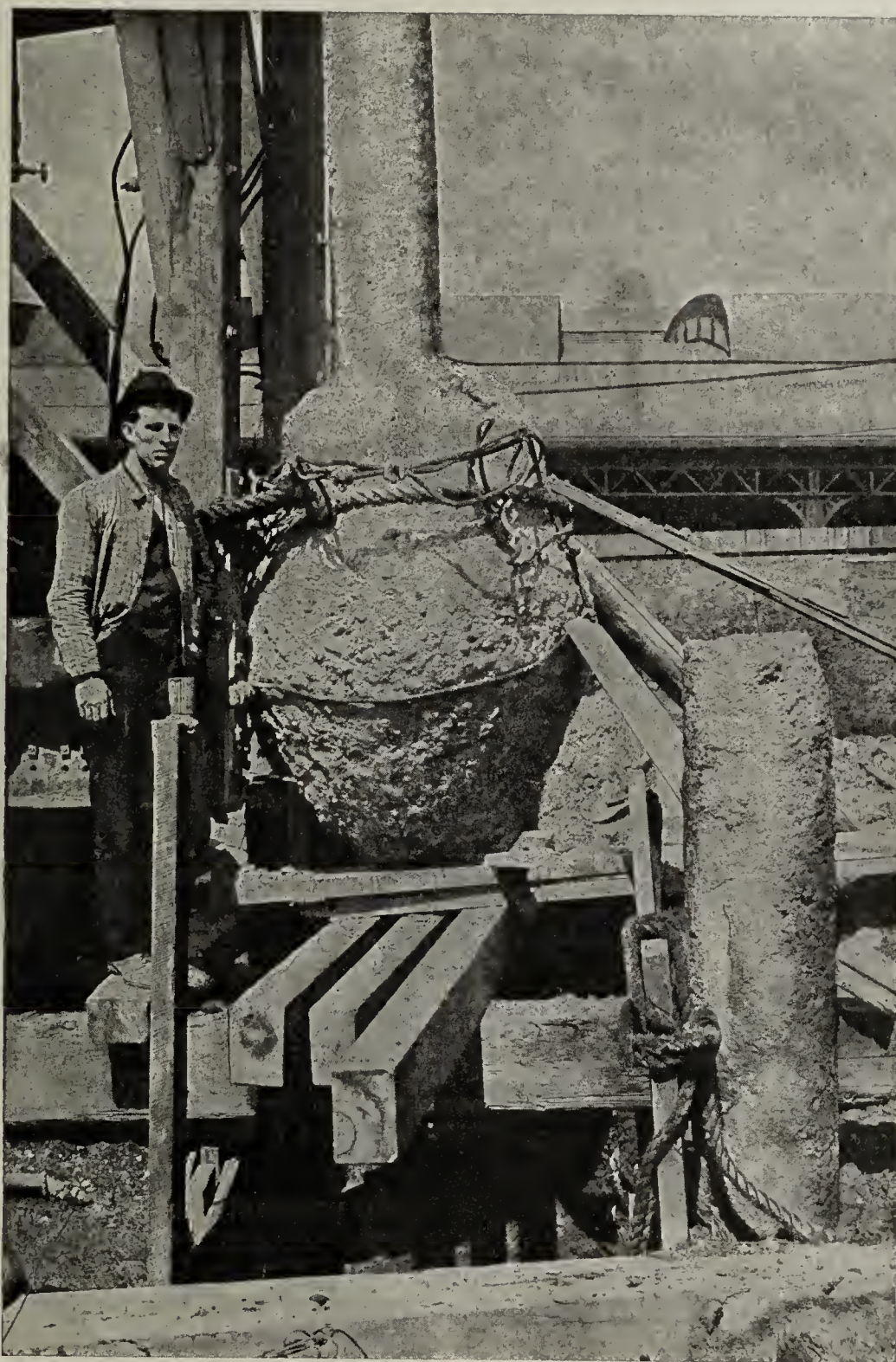
SEWER CONTRACT AWARDED.

The White Construction company has been given the contract for the building of a main sewer more than a mile in length. The sewer will be of concrete and the contract price is \$97,200. It is to be completed within the present year for the city of Kenosha, Wis.

Pedestal Concrete Pile Foundations

In construction work where the surface soil is soft, marshy, etc., and where the building to be carried is of considerable weight, it is found necessary to either excavate so as to put masonry footings down on the firmer subsoil or to use some form of piling. For centuries wooden piles have been used in sites of this character, and have in many instances, especially where the wood was continuously submerged in water, supported their load without failure. In recent years the scarcity of timber, as well as the increased loading pos-

sible with piles made of concrete, has caused a growing use of that type of foundation. Still more recently it has been found that by a very simple adaptation of the method of forming concrete piles in the earth a foundation can be achieved which approximates very closely to a masonry footing on the subsoil, while on the other hand it still retains the many advantages of piling.



The large spread base of the Pedestal Pile. This Pedestal Concrete Pile was formed in soft soil at St. Louis, Mo., and was dug up for inspection. The broad footing enabled the Pedestal Pile to carry the same load as a tapered pile, of nearly twice the length, driven in the same soil.

Foundation engineers have long recognized that if a

The advantage of a "Pedestal Pile" lies in the fact that the broad base is obtained by a simple process of bulging or mushrooming the concrete out at the lower end of the pile stem. This process can be best explained by referring to the accompanying Figs. 1 to 5. The apparatus necessary consists of a steel core and casing fitting into it. The casing is a steel pipe, 16 inches in diameter and three-eighths inch thick, with outside reinforcing bands. The core is a smaller and

longer pipe, with cast-steel point and an enlarged cast-steel head. The core fits inside the casing, its enlarged head engaging the top of the casing and its lower pointed end projecting some four or five feet below the casing. The core is fitted into the casing, and both are driven into the ground to the desired depth, as indicated in Fig. 1.

The core is then pulled out and a charge of concrete is dropped to the bottom of the casing, as in Fig. 2. The rammer is now lowered into the casing and driven down through this concrete, as shown by Fig. 3. The concrete is compressed, and is forced out against the soil, pushing back and compacting the surrounding earth. The operation is repeated, and the rammer being withdrawn, another charge of concrete is dropped down inside the shell and the rammer again driven through it, causing the concrete to be forced out still further into the surrounding earth. This process is continued until a sufficient volume of concrete has been rammed down to insure a footing of the desired size. The ram is then removed, the casing is filled to the top with wet concrete and the casing is then removed slowly and evenly, the concrete falling into position and filling out the thin space formerly occupied by the casing. The resulting pile is a column 17 inches in diameter, with the enlarged base or pedestal, as shown in Fig. 4. Fig. 5 is a photograph of a pile formed in this way, dug up for the purpose of inspection.

It is, of course, to be expected that a pile of this kind would carry a greater load than a pile without the broad base. The carrying capacity of a pile is in general due to two causes, the frictional resistance of the stem with the surrounding earth and the direct bearing of its base on the subsoil. Now, the stem of the "Pedestal Pile" is in frictional contact with the earth, just as is any other pile, and it can support a fairly large load by frictional resistance. In addition, it sup-

Pile" has an area of about seven square feet. It follows, then, that even under the most adverse conditions the additional loading capacity derived from this foot will be 15 or 20 tons.

As the amount of frictional resistance with the column, while of fairly definite value is subject to many changes, engineers have found the "Pedestal Pile" an ideal type of pile, in that they can calculate the direct bearing power of the base and know that the pile will carry that load without settlement. As in the majority of sites the subsoil can carry at least four or five tons per square foot, a safe load per pile is thus readily obtained of 30 or 40 tons.

A test was made on a "Pedestal Pile" where 50 tons was carried without any settlement whatsoever. This

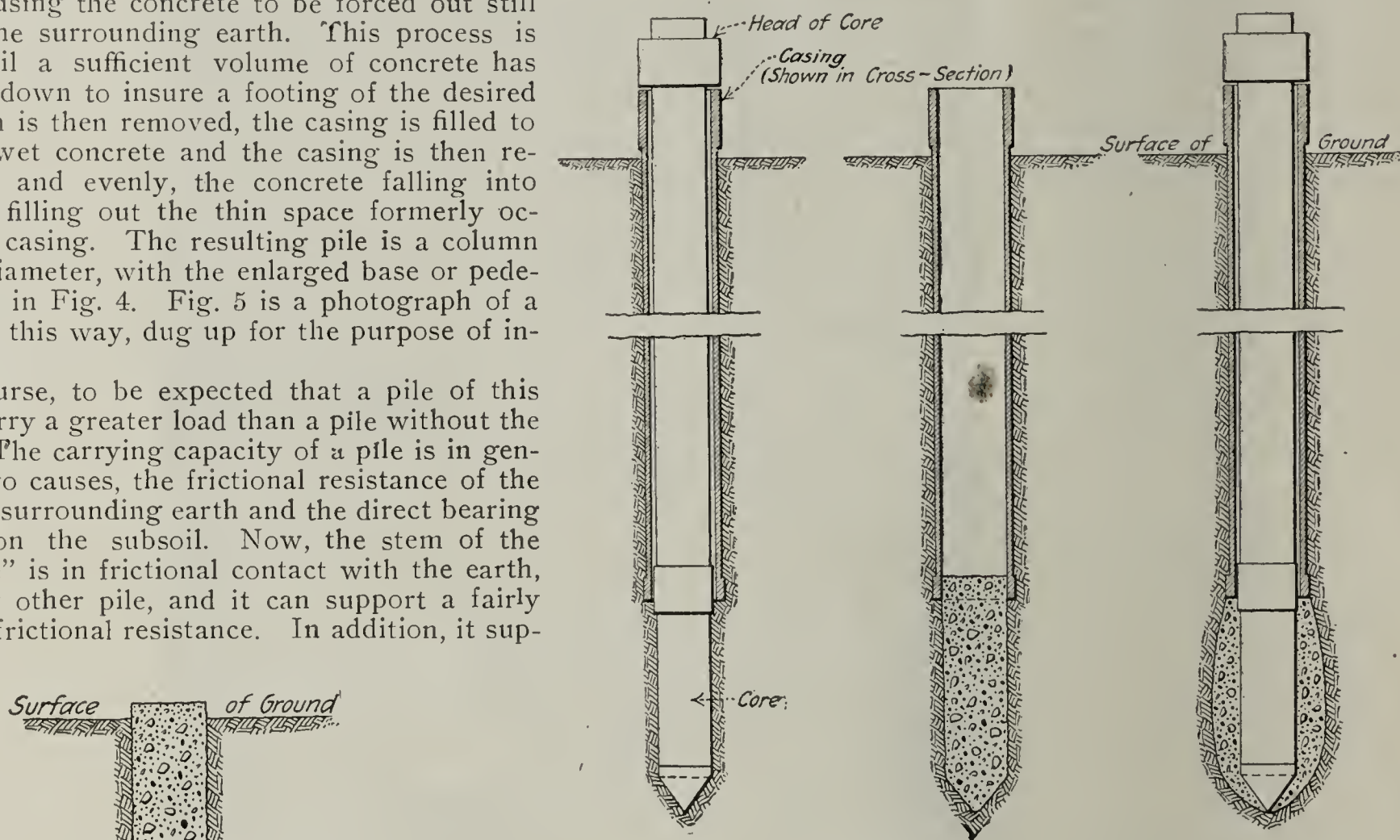
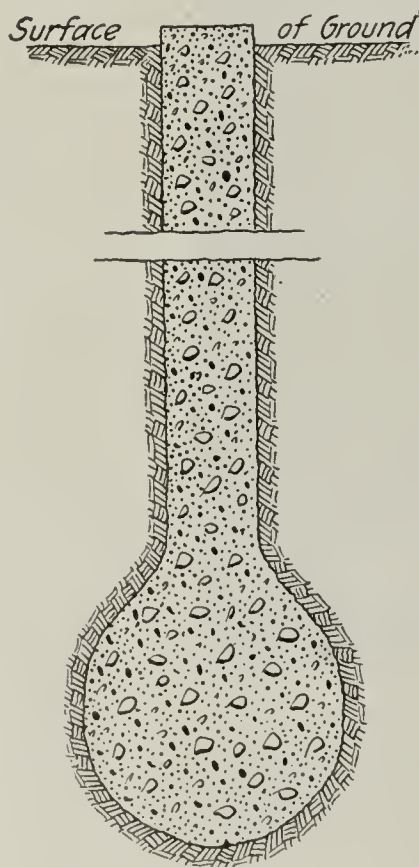


Fig. (1) A core and cylindrical casing are first driven to the required depth.

Fig. (2) The core is now removed and a charge of concrete dumped to the bottom of the casing.

Fig. (3) The core is now used as a rammer, to compress this concrete into the surrounding soil. The process is repeated until the base is about 3 feet in diameter.



ports a load by the direct bearing of its base upon the subsoil. By a study of the data on the direct bearing power of soil, it will be noted that down 30 or 40 feet below the surface soil a direct bearing power of two or three tons all the way up to 15 tons, where good hard pan is met, and as high as 100 tons where bed-rock is encountered, may be safely supported per square foot of bearing area. The foot of the "Pedestal

pile penetrates sand and mud, all of which is wet and soft. Its foot penetrated for a few feet into a soft blue clay. The load of 50 tons remained in position for 24 hours without causing any perceptible settlement. Another interesting test was made where three piles formed in soft muck and mud overlying a sand subsoil supported without any settlement the test of 115 tons placed upon them by the engineers of the Oregon & Washington Railroad. The load was later increased to 135 tons, no settlement being perceptible.

The "Pedestal Pile" is patented in the United States and foreign countries, and fully protected by the McArthur Concrete Pile & Foundation Co., 11 Pine Street, New York.

New Address of Cement & Engineering News,
 1117 Schiller Bldg., Chicago, Ill.
 Tel. Randolph 934.

The New Piedmont Portland Cement Mill is Now Completed and in Operation

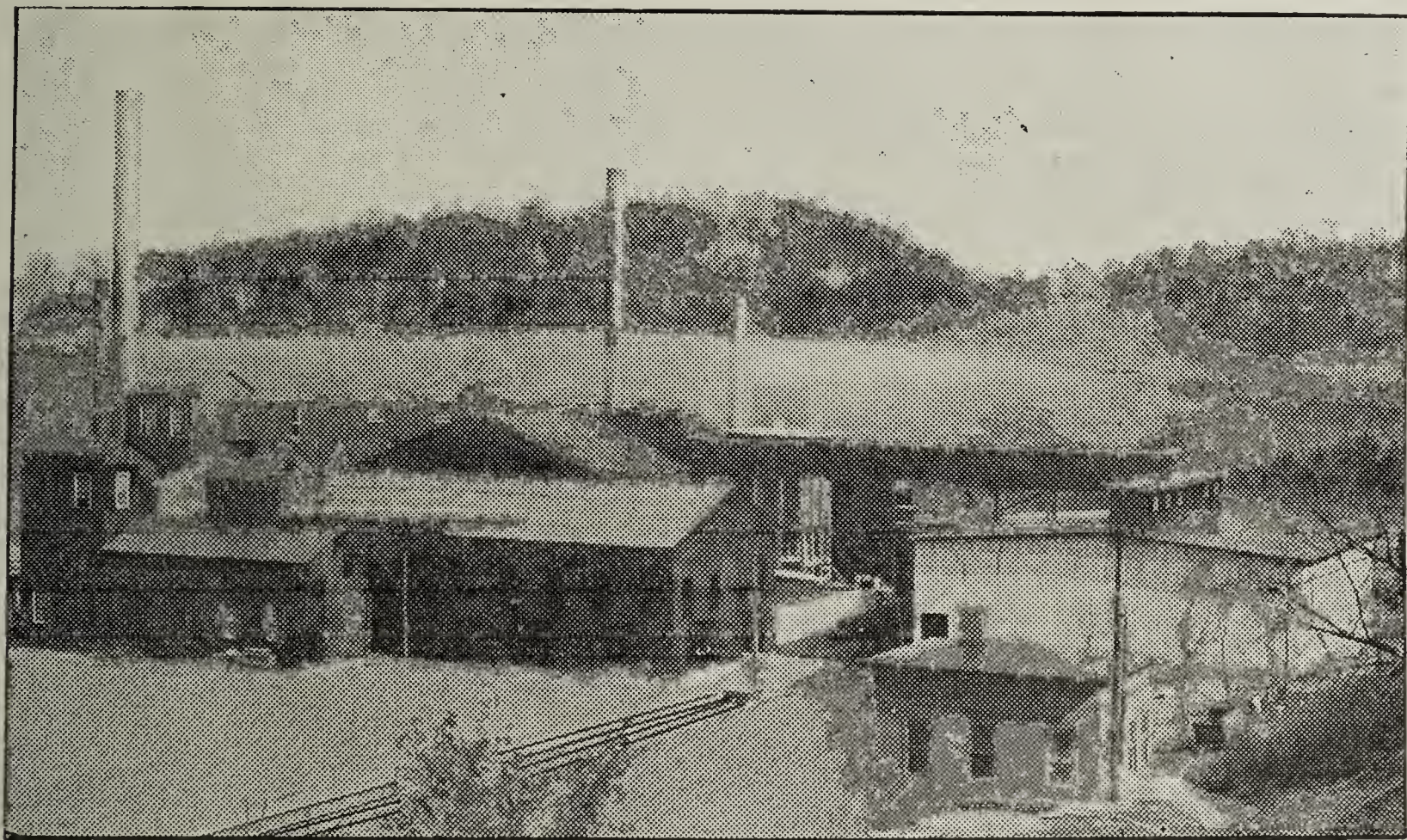
It is officially announced that the factory of the Piedmont Portland Cement Co., is now completed and in operation. This plant is located on the Seaboard Air Line a few miles out from Rockmart, Georgia.

The supply of raw material at the disposal of this company is practically inexhaustible, and unsurpassed for quality. A mountain of limestone 250 feet in height with excellent shale in almost the exact proportion required for the manufacture of Portland Cement gives enough raw material to turn out 1,000 barrels of cement a day for 100 years. The first cement turned out gives evidence of the fact that this material is of the finest quality, and the product will be equal to any cement in the United States for color, tensile strength and uniformity.

The cost of getting the raw material to the mill is very small. With practically no stripping and a quarry so situated that the loaded material can be carried to the crushers by gravity, it will be seen that the great-

preliminary crushers by a special scale manufactured by the Rome Scale & Manufacturing Co., and dumped into the dryer together. All the dryers were made by the Manitowoc Engineering Works. A Chalmers & Williams ball mill is used to prepare the dried material for the fine grinding on the raw end, which is done by the 42" Fuller mills; in fact all the fine grinding is done by Fuller Mills, a 33" mill in the coal room and two 42" mills for pulverizing clinker. The kiln, which is one of the largest in the South being 125 feet long and 8 feet in diameter, was manufactured by Chalmers & Williams. The cement is sacked and prepared for shipment by a special machine built to order in combination with a Richardson scale. All the electrical equipment is installed by the Western Electric Co. All this machinery is as good as can be had for the manufacture of an excellent quality of cement and is proving highly satisfactory.

The output of this new plant is 600 barrels daily.



Another Modern Cement Plant in the South.

est expense of quarrying is breaking and drilling. The drilling is done with the most modern Drills, operated by steam. Climatic conditions are such in the North Georgia Mills that there are few days during the year when outdoor work cannot be carried on without inconvenience, so a small quarry crew will be able to keep the bins full of raw material.

The plant is equipped throughout with modern machinery driven by a combination of steam and electrical power. The raw and finishing ends will be driven by a 500 horse power Corliss engine while the burning and coal-grinding departments will have a motor drive. The stone and shale from the quarry are broken down by a Williams crusher and a Jeffrey Pulverizer. To insure a thorough and uniform mix the crushed materials are weighed just after leaving the

Plans are now a foot to increase this to 1,200 which will be done within the next few months. The plan on which the mill is built, makes it possible to install the extra machinery required for this increased output at a very low cost; in fact most of the equipment necessary to produce 1,200 barrels every 24 hours is already in place. The management is so highly pleased with the result of the preliminary operation that they are going to work at once to double the capacity.

The product of the new mill will go into the market under the brand of "PIEDMONT" and with raw material of such excellent quality, machinery of the most modern type and superintendency and operation in the hands of able and experienced men, there is no reason why "PIEDMONT" Portland Cement should not establish a standard of superiority in the South.

The Car System in Cement Drain Tile Manufacture

By Charles E. Sims

The car system of handling cement tile in the factory admits of the highest possible rate of production with the least labor. It is expensive to install but gives a plant so equipped every advantage.

The car system can be installed for about as follows:

100 cars, 36 or 40 inches wide by 8 feet long, with angle iron corner posts and two decks,	
@ \$20.00	\$2,000.00
Freight and drayage on cars, 100 mi. @ 60 cts. cwt.	330.00
Labor assembling cars, shipped knocked down	40.00
Two transfer cars @ \$25.00.....	50.00
Freight and drayage.....	7.48
1,114 ft. of track indoors, 12-lb. rails, for rails, splices and bolts, @ 18 cts. per ft. of track.	200.52
Freight and drayage.....	20.00
640 ties, 4"x3'—6" @ 7 cts.....	44.80
Labor laying and grading @ \$2.00 per 100 ft. track	22.20
One switch, installed.....	40.00
600 feet of track in yard @ 18 cts. per ft.....	128.00
300 ties, 4"x3'—" @ 7 cts.....	21.00
Labor laying and grading @ \$2.00 per 100 ft.	12.00
Freight and drayage.....	14.00
Superintendence	20.00
Total	\$2,950.00

Allowing 8 per cent per annum for maintenance and 6 per cent for interest on the investment we have an annual charge of \$413.00 against the car system. If we are to compare it with the rack system this charge shows to the disadvantage of the car system. Although the car system requires a larger building, this fact does not operate to further disadvantage because the expense thus involved is offset almost exactly by the cost of the planks, partitions, etc., for the rack method.

Labor—Considering the labor from the time the tile are formed until they are piled in the yard the car system requires the following number of men.

4"—5" or 6"—two strippers, one man to push the filled cars into the curing room and bring up empties, two men to unload cars in the yard; total, 5 men.

7" and 8" Tile—Above mentioned five men and one additional to assist with cars and to relieve strippers, six men.

10" and 12" Tile—Above mentioned six men and one additional in yard; total, 7 men.

Rate of Production—A ten-hour run under these conditions should not be attempted on sizes larger than 6" for the number of cars here considered is not sufficient unless a small size is run one-half the day and a large size the other half. And, in fact, it would be impracticable to require any crew of men to work on the sizes above 6 inch, possibly I might say 8 inch, for more than five hours, if the highest rate of production is to be obtained. Under these conditions the following runs have been attained as an average for a season:

4,600—4" in 10 hours.....	920
4,500—5" in 10 hours.....	900
4,300—6" in 10 hours.....	860
4,000—7" in 10 hours.....	666
3,700—8" in 10 hours.....	616
1,700—10" in 5 hours.....	243
1,400—12" in 5 hours.....	200

The car system offers a means of accurately counting the tile produced. The man who pushes in the

cars counts the number of tile on each car and enters it on a card provided him. The count is taken when the car is on the transfer just before it is pushed into the curing room. The record is easily kept if a card 3½"x7" is ruled off lengthwise into four columns. Head the first column "Number of Tile;" the second column "Track Number;" the third column "Number of Tile;" and the fourth column "Track Number." After counting the tile enter the number on the car in column one, and the track number on which it is run into the curing room in column two. Each car can thus be kept on record. At the end of the day the total number of tile manufactured can be footed up exactly and recorded on the office books.

Another advantage of the car system is that the broken tile can be taken off by the man who runs in the cars and the material while fresh returned to the machine.

By recording the position of each car in the curing room it is possible for instructions to be written out each night showing to the yard man just what cars are to be unloaded the next day. With this system there is no danger of running out the tile too green.

Aside from the advantages named we have another of a different type, but one worthy of your attention. It is impossible for a crew of men to work with as good spirit and to accomplish as much in the low ceiling, poorly lighted and poorly ventilated curing rooms, where the rack system is in use, as the same men can do with the car system. In this case the machine is located where the light and ventilation are the best in an open, uncrowded space, and all the heavy work is done there. There is no tiresome walking, no confusion, and all the work is within the superintendent's sight at once. Certainly the greatest efficiency can be attained under such conditions.

The tile once on the car remains untouched until the car is run out into the yard and there it is unloaded. The rack system requires an extra handling of the tile, for it is necessary to take them off the racks and load them onto trucks to be wheeled out to the yard pile. Not only does the car system save this extra handling but it saves the breakage which goes with it.

CONCRETE POLES.

Concrete poles, hexagonal in shape and hollow through the center, are used by the Oklahoma Gas and Electric Company. A 35-foot pole measures 7 inches across corners at the top and 16 inches across at the butt. They are molded in forms made up of 5-foot sections so that it is possible to cast a pole of practically any length. Steel rods placed symmetrically about the central axis and at the top and bottom project through holes in a steel plate. The rods are bent over at each end securely fastened. The core, which is wrapped with one thickness of building paper, is suspended within the form by wires at intervals along its length. The concrete used consists of a mixture of 1 part cement, 2 sand and 3 parts chats or zinc tailings, which can be obtained from the zinc mines of Missouri.

A charter has been granted the Atlanta White Stone Company with a capital stock of \$50,000, with the privilege of increasing the same to \$100,000. This corporation will engage in the manufacture of architectural and ornamental cast concrete stone for both exterior and interior purposes, in all colors, especially pure white.

Notes on Making and Laying Concrete Pipe

By J. Alden Griffin

The best mixture for making concrete pipe up to 20 in. in diameter, under heads of not exceeding 15 ft., has been found to be one part Portland cement to four parts clear sharp sand and gravel. For pipe 20 in. in diameter and larger one part Portland cement to three parts clean sharp sand and gravel. To all batches add hydrated lime to the amount of 5 per cent of the weight of the cement.

The sand and gravel used should be absolutely free from dirt, silt or organic matter, and no gravel should be used that is larger than half the thickness of the pipe to be made. This may be easily gauged by using the proper mesh screen.

Never slight the mixing. Thorough mixing is of prime importance. Mix three times dry and two or three times wet and make it just wet enough to ball by pressing in the hand. When the mix is too wet it will stick to the mold and crack when the jacket is removed.

Tamping must be very carefully done. Every inch of the circumference should be tamped. During the placing of the material in the form and tamping, care should be exercised to keep the core exactly in the center to prevent the pipe from being thicker on one side than the other.

The importance of curing cannot be overestimated. Pipe made of the best materials can be ruined, if not properly cured.

After a joint of pipe has been molded it must be set on level sound ground in the open air to cure. If there is danger of freezing, place the pipe in a shed or under a canvas to cure.

After the pipe has set for about thirty minutes sprinkle with a fine spray from a hand sprinkler. After two or three hours it should be drenched and kept wet and not allowed to dry for a week after making.

After seven days of curing the pipe may be dipped in a thin solution of cement and water or a cement wash applied with a whitewash brush. Pipes from 4 in. to 12 in. diameter should be dipped. All pipes should cure for at least 21 days before being laid in the ditch.

Trenches should be dug in as near straight lines between stands as is possible, to avoid too many angular joints, which are hard to make tight.

The trench should be made wide enough for a man to stand with one foot on each side of the pipe without touching it. The accompanying table gives width of trenches for various sizes of pipe recommended for practice.

Trench Widths For Concrete Pipe.

Pipe Size	Trench Width.	Pipe Size.	Trench Width.
6 in.	18 in.	20 in.	35 in.
8 in.	20 in.	22 in.	40 in.
10 in.	24 in.	24 in.	45 in.
12 in.	26 in.	26 in.	48 in.
14 in.	29 in.	30 in.	52 in.
16 in.	30 in.	36 in.	56 in.
18 in.	32 in.		

The bottom of the trench should be made as near an even grade as possible, to avoid too many little si-

phons which cause air chambers in the pipe and if very short cause bad joints due to sharp angulation.

Before any pipe is placed in the trench a small excavation shall be made in the previously prepared bed of the trench to receive the bands at the joints, so that each pipe shall have a firm and uniform bearing over its entire length.

Never place clods under the pipe to raise it to line. Use a shovelful or two of dirt and compact it by tamping to get the required grade.

A little extra time spent in laying the pipe line to make sure each joint is properly made will save a great deal of extra expense patching up leaks after the line is tested.

Never lay pipe down hill, always up; this allows the shrinkage of joints to take place without cracking the bands, as the weight of the pipe is on the joint instead of pulling away from it.

Never place dirt on a newly made band to shade it. It absorbs the moisture from the mortar and renders it practically worthless. It is well to shade new bands from the direct rays of the sun for a least 30 minutes before placing any back fill on them, but use a canvas or board laid across the trench instead of dirt. After the bands have set for at least 30 minutes again wet them and then back filling can be done.

After a section of pipe has been laid and the joints allowed to set as aforesaid, it must not be disturbed by stepping on or near the pipe line or by throwing earth upon it from the bank above, but fine earth, free from stones, shall be carefully deposited in the trench and firmly compacted around the pipe up to a level of about 1 ft. above the top of the pipe; from there on up to original grade, it may be handled with less care, but never allow a workman to jump on it to compact it.

If the top of the pipe is within 2 ft. of the natural surface great care must be used in preventing driving over or upon the pipe line until the fill has had sufficient time to thoroughly compact in the trench.

The lines should never be put under pressure until the joints have had at least 36 hours in which to set and preferably 48 hours.

After a line has been tested and found faulty and the leaky points staked out, it should be drained and the leaks uncovered. If the leak is found to be on the bottom side of the pipe tap a hole in the top of the pipe large enough to permit a man's hand to enter and scour the inside of the pipe with clean water and a steel brush. Apply a thin layer of cement mortar on the inside and scour the outside in the same manner and pick little depressions in the pipe around the leak and apply a band of cement mortar. Fit a concrete plug in the tapped hole in the top of the pipe and cement in place, picking the pipe around the plug to insure good adhesion of mortar to pipe.

Above all things scrub the pipe absolutely clean before applying mortar.

The Keystone Cement Construction & Manufacturing Company of Waupun, Wis., expects to erect sixteen residences in different parts of the state before fall. They recently amended its articles of incorporation, increasing their capital stock to \$100,000.

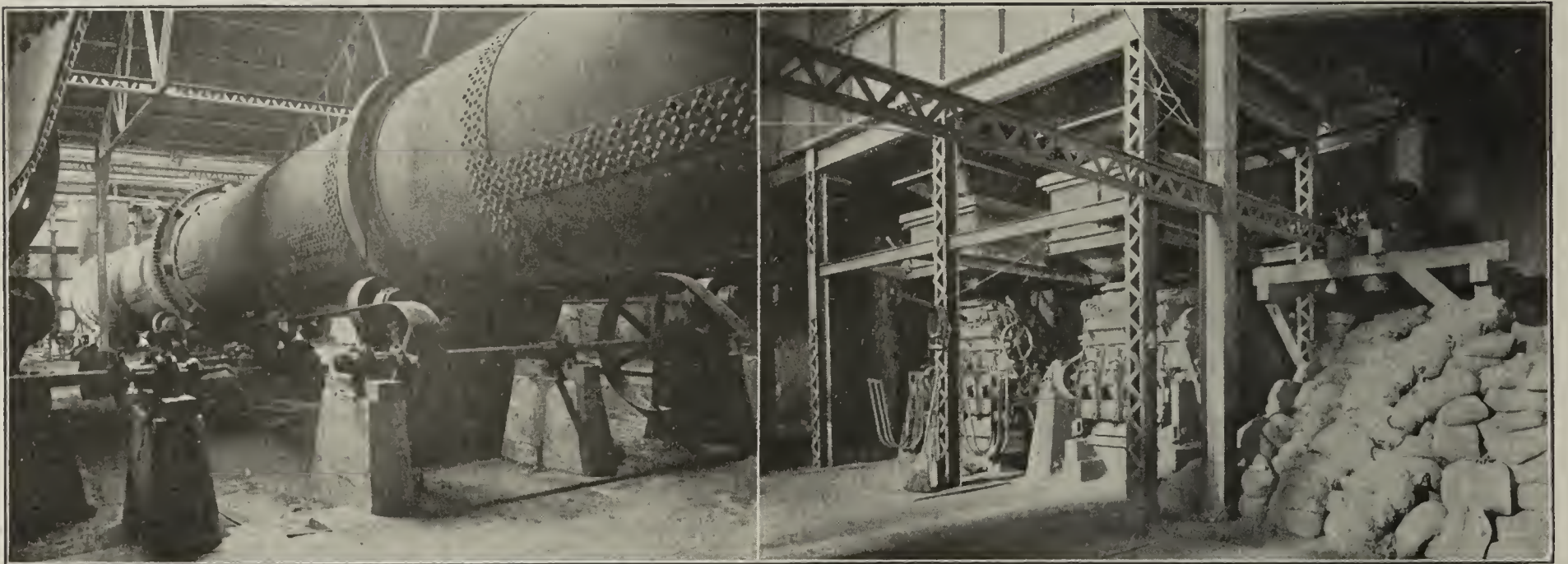
The Electrical Equipment of the New Allentown Portland Cement Plant

The electrical features of the Allentown Portland Cement Company of Evansville, Pa., are of interest in that the Company's plant is typical of the latest cement mill practice. As the mill was constructed by the Fuller Engineering Company, which Company has built several of the best cement mills in the country, its design can be accepted as a standard of the day. The mill was opened on May 1st, 1910, and since then has been operating continuously. It has a capacity of 2500 barrels per day with arrangements for increasing this to 5000 barrels per day without interrupting production. The operations in the mill and their sequence are as follows:

At the quarry the rock is located onto dump cars with a steam shovel. Two hoists, each driven by a

motor on the driers. In this case a 50 h. p., 470 r. p. m., type CCL motor is belt connected to a line shaft from which three 7 ft. by 50 ft. driers are driven. Each drier is connected to the line shaft by belt drive and the speed is further reduced through two sets of spur gears and one set of bevel gears. As will be seen in the right foreground of the picture, bearing ring rollers idlers are placed sufficiently close together to preclude large bending moments. The 50 h. p. motor mentioned also supplies power to the shaking feed arrangement from the stock bins to the driers.

From the belt driers the material is carried to the stone storage on a belt conveyor driven by a 40 h. p. motor. A smaller conveyor driven by the same motor takes the material to the raw mill.



Interior Views of Kiln Room and Packing Department. Machines Driven by Westinghouse Motors.

50 h. p., 750 r. p. m., wound rotor motor, take these cars up an incline to the crusher house. The cars discharge into an elevator which discharges into a No. 10 Gates crusher. This crusher discharges into a second elevator which delivers the material to three No. 6½ Lehigh crushers, where the material is further reduced. A 250 h. p. motor supplies the necessary power for the crushing machinery. It is interesting to note here that although individual drive was adopted through almost the entire plant, line shaft was installed in the crusher house. The reason for this is that the load on a gyratory crusher is intermittent and frequently comes on so quickly that it constitutes a severe shock; by using line shaft drive a shock produced by any particular machine can be absorbed by the inertia of the other machines and moving parts of the system. The discharge from the smaller crushers is lifted to conveyors which carry the material to the large bins adjoining the driers. The storage bins are equipped with automatic shaking feeds, by means of which a constant flow of material to the driers is effected.

The accompanying figure I shows details of the

In this mill the material is delivered to two No. 8 Krupp ball mills, each driven by a 40 h. p. motor. These mills are used in preparing the mixed raw materials for the Fuller mills. The material is discharged from these ball mills on to several elevators driven from line shafting belted to a 40 h. p. motor. These elevators distribute the material into a storage bin over the Fuller mills by means of a screw conveyor. The material is fed from the bin into eight 42-inch Fuller mills, each driven by a 75 h. p. vertical belted motor. These vertical motors are operating very successfully and have proved distinctly advantageous as compared with horizontal motors with quarter turn belts. The material is conveyed from these Fuller mills to a large storage bin over the kilns by means of a bucket hoist driven by a 10 h. p. motor. The material is conveyed into each kiln by an inclined feed pipe which receives its supply from the screw conveyor. There are four kilns Fig. 2, 8 ft. by 120 ft. each driven by a 30 h. p., 750 r. p. m. type HF motor.

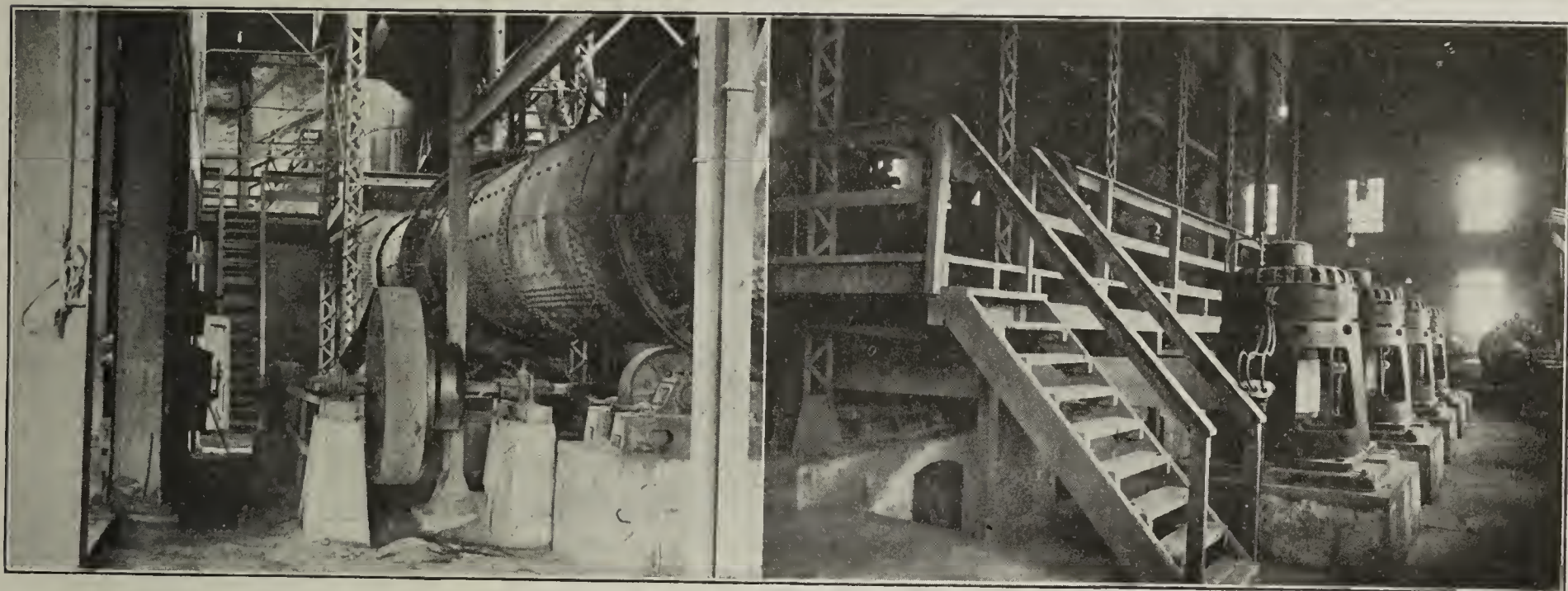
The coal for firing the kilns is brought from a hopper below the tracks and carried by means of an elevator and conveying system driven by a 40 h. p.

motor to the top of the coal storage. The material is conveyed by gravity into a set of rolls in the pit which reduces the large lumps. An elevator discharges the crushed coal into two 4½ ft. by 30 ft. Matcham driers, from which the material is again elevated and discharges into the bins over the pulverizers. The pulverized coal carried by a screw conveyor and an elevator to the bins in front of the kilns. One 30-h. p. CCL motor drives the three elevators and the screw conveyor handling crushed and pulverized coal. The pulverized equipment consists of two 42-ins. Fuller Lehigh mills driven by a 75 h. p. motor. The motor for each kiln is placed in the small pit below the surface of the concrete floor, small openings in which permit the passage of the belt to the pulley seen on the three-bearing shaft visible in the foreground of the picture. Further speed reduction is effected through two belts, one bevel gear and two spur gear connections.

The speed rotation of the kilns is low, about 1 and 1½ minutes to the revolution. Provisions must be made in the motor drive to vary the speed of the kiln to suit the charging conditions in burning. In some alternating current installations, using induction mo-

tors, a motor generator set has been provided to supply ball mill is discharged into the same elevator that delivers the material to the Fuller-mills. The ball mill is driven by a 40 h. p. motor. Between the rows of finishing mills there are two conveyors discharging into the common elevator that delivers the material to a screw conveyor connecting the finishing mills with the store house; this system is driven by a 40 h. p. motor. Three screw conveyors, all driven from a 30 h. p. motor carry the material from the bins in the stock house to the bagging house, and a 20 h. p. motor supplies the power for the elevator that delivers the cement to bins above the baggers. Two pairs of Bates valve bagging machines are used for bagging the cement, each pair being driven by a 30 h. p. motor.

Each building has its separate control panel, distribution to which is made from the power house about 1300 feet distant by means of 4-0 B. & S. G. wire. Energy is generated by three Westinghouse 937-Kw., 600-volt, 3-phase, 250-cycle, 100 r. p. m. alternating current generators direct connected to Wetherill cross compound engines. The exciter unit consists of a 150 h. p. alternating current type CCL motor driving a



Views of Drier Department and Fuller-Lehigh Finishing Mills. All Machines Driven by Westinghouse Motors.

ply direct current for operating the motor for the kilns, but in the plant under discussion alternating current slip-ring motors with wound secondaries were chosen and have operated with entire satisfaction, the speed changes being obtained by varying the resistance in the secondary of the motor.

Two kilns discharge into a common bucket elevator which feeds the material into the rotary coolers. There are four coolers all operated by 50 h. p. motor. The two bucket elevators for these are driven by a 20 h. p. motor. A belt conveyor takes the material from the coolers and delivers it to an elevator discharging on to a belt conveyor, which distributes the clinker to the storage.

From the storage where the clinker is permitted to season it is taken to the gypsum house by means of a belt conveyor driven by a 10 h. p. motor; an elevator driven by a 10 h. p. motor takes the material to the finishing mill where it is discharged into a rotary screen, with ¾" holes. The material which passes through then goes directly to the eight Fuller-Lehigh finishing mills each of which is driven by a 75 h. p. vertical type motor. The coarse material is fed into a No. 8 Krupp ball mill, and the resulting product from the

100 Kw., 125-volt generator at 720 r. p. m.; an engine driven 110-Kw., 135-volt, 125-r. p. m. generator is provided. A Skinner engine.

In a cement plant the power demands are more exacting and the operating conditions are more severe than in other manufacturing processes. The presence of great quantities of highly abrasive dust, the inflammability of the finely powdered coal, the heavy torque required by the machinery and the nature of the load all go to make up a problem in motor drive that requires the most careful consideration for its solution. Induction motors have solved the problem. The Allentown Portland Cement Company's plant furnishes one of the best examples of motor drive for cement mills. Great simplicity has been effected in the layout of the machinery. Individual drive on the principal machines, including those of burning and grinding departments, offers the advantage that expensive and troublesome clutches are unnecessary and also that during the shut down periods of any particular machine the entire friction load of that unit is nil. With line shaft drive the use of even one machine of a department means an exceeding heavy friction load.

Concrete Abutments for Highway Bridges

By H. E. Bilger, Asst. Engineer Illinois Highway Commission

The use of concrete as a material of construction is now recognized as one of the best, one of the most economical, and consequently is one of the most common materials now being employed in structures where permanency is the important end to be attained. This was not the case twenty years ago, not that engineers were not even at that time fairly well familiar with the properties of cement and concrete, but rather for the reason that the arrival of a first-class Portland cement on the market at a comparatively low figure has enabled concrete to become more and more employed in structures where but a few years ago the first cost would have seemed prohibitive.

This brings us to a field of construction with the magnitude of which but few are familiar. The principal reason for this is that highway bridge work in each particular community is handled by the local people at hand, and while the expenditure for bridges for one county for one year may not exceed ten or twenty thousand dollars, yet the accumulation of these small expenditures taken the state over runs into millions of dollars every year. It was the appreciation of the magnitude of the annual state expenditure for highway bridge work that prompted the legislature that created the Illinois Highway Commission to provide that this commission shall use its influence in directing

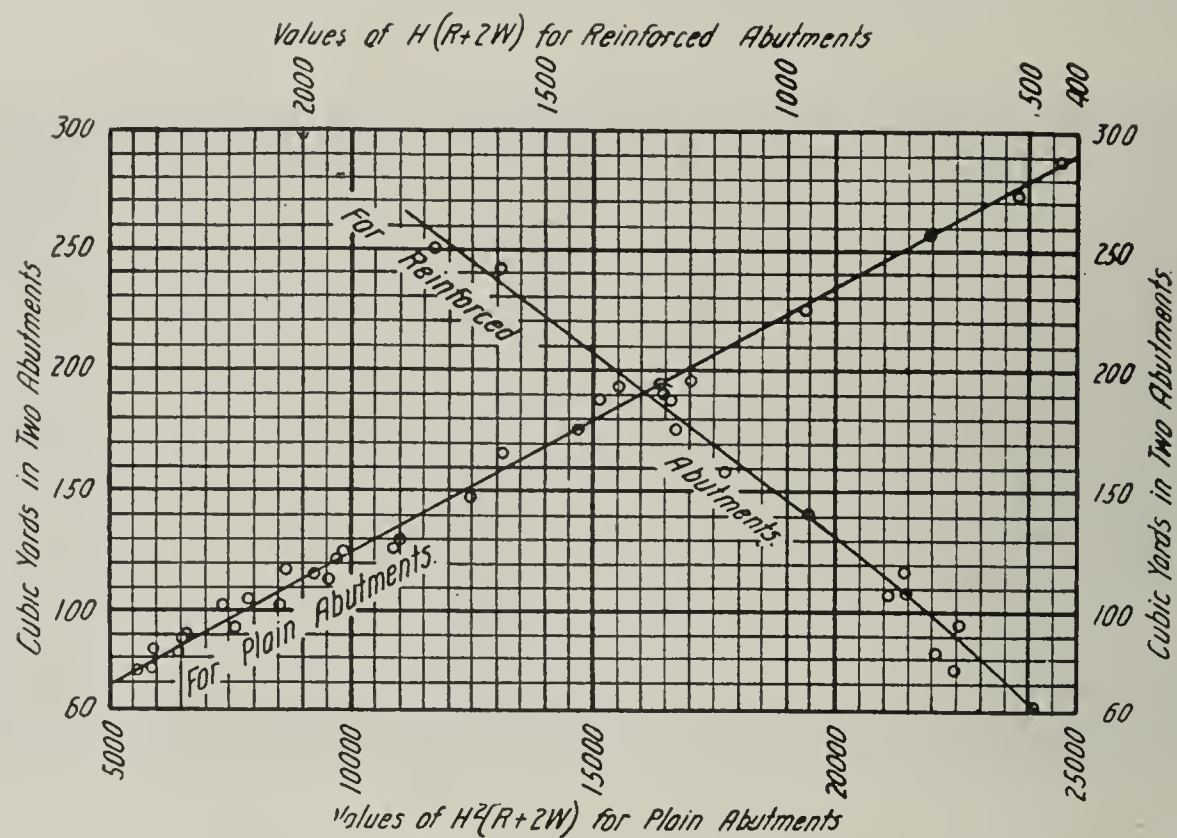


Fig. 1.—Diagram for Determining Quantities in Concrete Abutments.

There are few that get greater returns per dollar invested than do the corporations, and particularly the railroad companies of this country. Consequently it is but natural that we should see the railroad companies adopt the use of concrete practically to the exclusion of all other forms of masonry. Strange to say, one of the foremost railroads of this country was about the last one to permit stone masonry to be supplanted by concrete, and the late chief engineer of this road is on record as having said that he did not believe it was possible for man to make a better stone than the Lord, by taking the Lord's stone, breaking it up into little pieces, and then sticking it together again. During the past five or six years this same railroad has spent millions of dollars in concrete construction work where it is their hope and belief that the first cost will be practically the only cost. In substructures for railroad bridge work concrete is especially applicable, chiefly because of its permanency and reliability; but it is none the less applicable in substructure work in connection with highway bridges.

the expenditure of public money along the most justifiable lines in bridge work as well as in road work. It was not until after statistics were gathered by the Illinois Highway Commission that it became known that in the State of Illinois more than two million of dollars are being spent every year on township and county bridges, to say nothing of the bridges that are strictly municipal affairs. The policy of this Commission at the outset was to devise a type of bridge construction that would at least finally greatly reduce, if not wholly eliminate, the expenditure now necessarily being made for what goes by the name of "bridge repairs."

In a paper presented to this society a year ago by Mr. A. N. Johnson, State Highway Engineer of Illinois, a full explanation is given as to the manner in which engineering services are rendered on bridge matters by the Illinois Highway Commission to the various townships, counties and villages throughout the state. In this paper is given an explanation of the through girder type of reinforced concrete bridge that has been developed by this commission as the one best suited

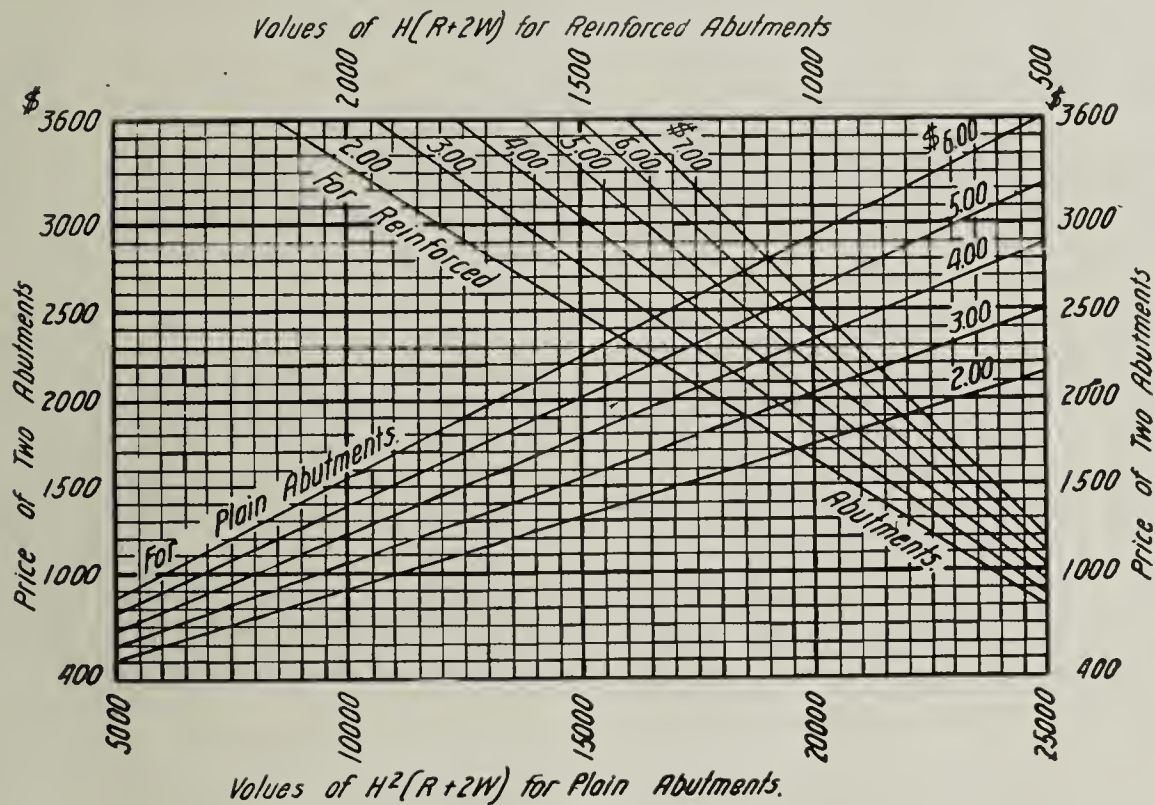
to the particular conditions prevailing throughout this state. Also there is given data on the design of these girder concrete bridges as well as cost data on a very large number of them that was constructed in the year 1909.

The purpose of the writing now at hand is to discuss the practice of the Illinois Highway Commission in the design of concrete abutments for truss highway bridges, and to develop a ready means of ascertaining approximately the number of cubic yards of concrete in a pair of abutments of a known height and length of wings, as well as to work out a means of making field estimates of the cost of a pair of abutments without calculating the quantities in detail.

To design economically a retaining wall and insure stability is a problem that is not susceptible of accurate mathematical solution. A great many formulae have been advanced that deal with earth pressure under different conditions, and as a rule they all give results that are safe; but the formulae themselves are necessarily based upon assumptions that are more or less unknown, and consequently for ordinary cases there is little or nothing to be gained in applying a sup-

At the end of the wing the width of the footing is 33 per cent. of the total height of the wall at this place, but it will be noted that with a height less than 13 feet, when we use the customary nine inch horizontal offset for the footing, the width of the wall at the top of the footing will be slightly less than 25 per cent. of the height. In these cases the width of the wall at the top of the footing is made 25 per cent. of the height above the top of the footing, and the horizontal offset of the footing is adjusted until the width of the footing is 33 per cent. of the total height. Wing walls are made twelve inches wide on top, and the total width of the abutment proper at the top usually varies from twenty to thirty-two inches depending upon the size of the shoe that is built for the superstructure. Eight inches of this top width is in all cases used for the parapet wall.

For the reinforced, buttress type of abutments it is the practice of the Commission to make the width of the base 33 per cent. of the total height for heights up to 30 feet. Needless to say that the stability moment of the buttress wall is somewhat less than that of the plain or solid type of wall. This of course being due



posedly rational formula to determine the stability of a retaining wall against overturning.

For plain abutments up to 25 feet in height the practice of the Illinois Highway Commission is to make the width of the base 33 per cent of the total height, except where the foundation is to be rock or shale, in which case the base is made 25 per cent of the height. This is in accordance with the practice of the English engineer, Benjamin Baker, who after a very long experience with retaining walls, concludes that a wall without any surcharge and having a batter on the face of one to two inches per foot, will be stable against overturning when the base is 25 per cent of the height, providing that the back-filling and the foundation are favorable. In ground of an average character the aforementioned engineer made the base of retaining walls 33 per cent of the height from the top of the footing. Our plain concrete abutments rest on a concrete footing that is eighteen inches deep vertically and projects nine inches horizontally beyond the front and the back of the wall proper. The back of the wall is made vertical, primarily so as to throw the center of gravity of the wall farther away from the toe, and secondarily for the sake of the appearance of the structure.

to the relative amounts of concrete in the two walls, but also because of the center of gravity of the concrete in the buttress wall coming more nearly to the toe of the wall than is the case with the plain or solid wall. True it is that the difference in the weight of the two walls is very largely made up by the weight of the back-filling occupying the space between the buttresses; but this compensating factor is not sufficient to make the buttress wall as stable against overturning as the plain wall when the ratio of base to height is the same in each case. Rather than increase the width of the footing in the buttress wall so as to have the design of the two types consistent, it is considered that the anchorage of the wings to the main wall by the horizontal reinforcement is sufficient to make up for whatever difference might exist between the stability of the two types of walls. This anchorage is not considered, however, in cases where the angle between the wings and the center line of the road is more than 45 degrees.

As is the case with plain abutments the width of the footing at the end of the wings is made 33 per cent. of the total height at that point. The footing depth is very frequently eighteen inches, but this may vary some six inches either way depending upon the design

required for the particular case in hand. The wall proper is arbitrarily made twelve inches wide at the top, but at the top of the footing it usually varies from eighteen to twenty-four inches as governed by the design. Three buttresses twelve inches thick are used behind the main wall and occupy the full width of the footing that remains back of the wall. In the wings the buttresses are placed some 6 or 7 feet apart on centers as near as practical, this depending on the length of the wings; but three buttresses for each wing is the number most commonly used.

The bridge work of the Illinois Highway Commission requires a personal inspection of the bridge site with the local officials, and at this meeting the necessary data are obtained for the design of the bridge. Almost invariably the officials will expect that an estimate of the cost of the proposed work be made them at this time. Consequently, to maintain the confidence of the officials it behooves one to be prepared to give an estimate that will closely approximate the one that is made from the detailed drawings. This is usually a somewhat difficult matter to do unless the time is taken to compute the number of cubic yards in detail that will be in the abutments. For the purpose of determining off-hand the approximate number of cubic yards in a pair of concrete abutments Figure 1 has been prepared, and is applicable within the limits shown by the specific cases used. For plain abutments 27 different designs were taken from the files of the Commission and the number of cubic yards in the two abutments of each design were plotted against $H^2 (R + 2W)$, where H is the total height of the wall, R the clear roadway of the steel superstructure, and W the length of one wing measured on the stream side of the wing. It will be noticed that the number of cubic yards in two abutments varies approximately as the square of the height. R was taken as the clear roadway of the superstructure for the reason that this is the figure that is gotten at the preliminary inspection of the bridge site. It will be noticed that the maximum variation from the line plotted is eight cubic yards, while the average is about three and a half cubic yards. For a particular bridge site, suppose the distance from the crown of the finished roadway to the bed of stream should be 14 feet, and that the footing should be carried to a depth of four feet below the bed of the stream, making H equal to 18 feet. If the wings are each to be 15 feet long and the abutments are to carry a superstructure having a clear roadway of 16 feet, we have a value of 14,900 to be read off at the bottom of the figure. It will be seen at once that there are 178 cubic yards of concrete in the two abutments. The 27 abutments used in making this figure varied in height from 12 feet and 4 inches to 24 feet and 3 inches, the average being 17 feet and 4 inches. The wings ranged in length all the way from 5 feet to 17 feet and 6 inches, the average being 12 feet and 2 inches. The width of roadway varied from 14 to 18 feet, but the large majority of them were 16 feet. The total width of the wall at the top varied from 20 to 32 inches, the average being 27 inches. In all cases 8 inches of this width is used as a parapet wall and comes to the top of the stringers in elevation, the remaining portion of the wall stopping in elevation at the bottom of the shoe. It might at first be thought that the number of cubic yards would be more nearly proportional to the height only up to the bridge seat, because of the height of the parapet wall being a constant for any given superstructure and is entirely independent of the height of the abutment. After plotting the quantities both ways it was found that

the number of cubic yards varied more nearly proportional to the total height of the wall. The angle at which the wings stood with respect to the main wall ranged in these cases from 30 to 60 degrees. The more nearly the direction of the wing approaches a parallel with the line of the road, the higher will be the wing out at the end, and consequently the number of cubic yards will be somewhat increased; but as the corner formed by the intersection of the abutment proper and the wing is measured twice, these two factors greatly compensate one another.

For reinforced abutments 15 designs were taken from the files of the Commission and the number of cubic yards in the two abutments of each design were plotted against $H \times (R + 2W)$, the notation being the same as before. It is to be noted that in reinforced abutments the number of cubic yards vary proportional to the total height instead of as the square of the total height as is the case with plain abutments. For a particular case, take the same abutments that were considered before, namely, clear roadway 16 feet, height 18 feet, and length of wings 15 feet, we have 828 as the quantity to be read off from the top of Figure 1. Getting the intersection with the line for reinforced abutments, we find that the two abutments would contain 120 cubic yards of concrete. Figure 1 is thus a ready means of ascertaining approximately the number of cubic yards of concrete in two abutments in terms of the height, roadway, and length of wings, when the design of the abutments is in accordance with the practice as previously described. Having found the expression that is a measure of the number of cubic yards in a pair of abutments, the next step is to correlate it with a unit price that we may be enabled to arrive at the approximate estimate. For this purpose Figure 2 has been prepared.

The actual cost of one cubic yard of concrete complete in place as an integral part of a wall will depend upon a number of individual items. For nearly all ordinary highway bridge abutments there are only two or three of these items that have a very large influence in determining what the actual cost per cubic yard shall be. These items are:

1st, the cost at the bridge site of sufficient aggregate to make one cubic yard of concrete.

2nd, the cost at the bridge site of sufficient cement to make this cubic yard of concrete.

3rd, the cost per cubic yard of concrete to make the necessary excavation to start the concreting of the footings.

There are exceptional cases where the cost of this excavation, which includes also cribbing, sheet piling and pumping, will run as high as three or four dollars per cubic yard of concrete. On the other hand, in a very few cases this excavation item may fall as low as 75 or even 50 cents per cubic yard of concrete. These are both very rare exceptions, however, and for probably as many as 85 per cent of all the cases encountered, the excavation item will not vary more than 30 per cent from a fixed quantity.

The item for mixing and placing concrete might vary from \$1.25 per cubic yard for crushed rock concrete mixed by hand, to possibly as low as 30 or 40 cents per cubic yard for gravel concrete mixed by machinery. In spite of this possible wide variation, we find that the cost for this item varies but little from a fixed amount. Likewise the item for forms is a more or less fixed quantity for plain abutments and another fixed quantity for the reinforced abutments.

It will be seen that the cost of the cement and the

aggregate delivered to the bridge site are the two items that have the most to do with determining what the price shall be per cubic yard of concrete.

For plain abutments the sum of these two items will very seldom fall below \$2.00, and will just as seldom exceed \$6.00. Under the most favorable conditions with respect to location with reference to the nearest railroad station, the cost of the cement delivered to the bridge site would hardly fall below \$1.50 for plain concrete mixed at the rate of 1-3-5. Even if satisfactory gravel is available at the bridge site, it would likely cost at least 50 cents per cubic yard to haul it to the mixing plant. On the other hand, the cost of the cement and the aggregate at the bridge site might even exceed \$6.00. In the light of this Figure 2 has been prepared to give the price of two plain abutments under conditions where the cost of the cement and the aggregate at the bridge site might vary from \$2.00 by \$1.00 increments to \$6.00, and for reinforced abutments where the cost of these two items ranges from \$2.00 to \$7.00. The items for forms, mixing and placing concrete, and excavation will be as nearly a constant for the reinforced abutments as they are for the plain abutments.

From the 15 different designs of reinforced abutments which were used in preparing Figure 1, it was found that the amount of reinforcing steel bars per cubic yard of concrete averaged 70 lbs., and that the widest variation from this average was a rather small per cent. This item for reinforcing steel, as well as the bending and placing of same, has been duly considered in preparing Figure 2, and likewise all other items that have a material influence on the cost of one cubic yard of concrete in place in the wall. For this reinforced work the mixture is 1-2½-4 as against 1-3-5 for the plain concrete.

Supposing that the aggregate and the cement at the bridge site for one cubic yard of plain concrete to cost \$4.00 and, using the same abutments that were previously considered we find that 14,900 at the bottom of Figure 2 intersects with the \$4.00 line for plain abutments at a point showing the price of the two abutments to be \$1770.00. Similarly, 828 from the top of the figure intersects with the \$4.00 line for reinforced abutments at a point showing the price of the two abutments to be \$1620.00. This is not actual cost of the abutments to the contractor, but rather the price of the abutments; it being the figure at which the township or county can expect to get the work done by contract. By correlating the expression that measures the number of cubic yards in a pair of plain abutments with the corresponding expression for reinforced abutments, it would be possible to work out a diagram that would show graphically by the intersection of lines the economical height for any particular set of conditions, but what is wanted rather than this is to get the absolute figure on a pair of plain abutments and the corresponding figure for a pair of reinforced abutments, both under the same conditions.

It is not the practice of the Commission to select the type of abutment merely upon the relative price of the two; there are important practical considerations that enter into this matter. A case frequently arises late in the season when the abutments must be built before freezing weather. The particular conditions might show that the reinforced abutments are the more economical by say \$100.00, but by the selection of this type the work would be delayed two or three weeks in getting the reinforcing steel from the mills. Again, a condition might be met where the frequency of freshets might make the contractor's

cost for pumping, cribbing, etc., exorbitant, and as it would likely require two or three times as long to carry the concreting up to the water surface by using the reinforced type as against the plain wall, the latter should be the design adopted, providing the difference between the cost of the two types would not be excessive. As a third case it might be mentioned that no small part of the concrete work that is done under the supervision of the Illinois Highway Commission is done by men residing in the local community and these men frequently have had very little experience with concrete. In spite of this fact, for ordinary work they stand on an equal footing at the letting with the experienced contractor, even though they are at sea when it comes to reading a plan of a reinforced abutment. This point, however, is not considered by the Commission in selecting the type of abutment, for the reason the Commission furnishes a competent inspector to superintend the construction of the work, so the complexity of the design is not an embarrassment to the local contractor.

One of the most gratifying phases of this work is the favorable attitude which the township and the county officials throughout the state are assuming with respect to the wisdom of permanent bridge construction as advanced by the State Highway Commission. As late as three or four years ago the officials in many of the communities were rather favorably disposed toward putting small bridges on steel legs resting on a mud sill, and the larger ones on steel tubes filled with concrete. A case very seldom arises now where the officials object to putting their bridge on concrete abutments, and when such an occasional case does come up, the objection is invariably due to the shortage of immediate funds, the value of concrete for substructure work never being questioned at all.

The old pile bent originally used to support a bridge gave way to the steel tube, which in turn was supplanted by the stone masonry abutment. Conditions have now changed again, and while it is not claimed that concrete has greater durability than first-class granite stone masonry, yet it is believed that concrete is admirably adapted to the construction of highway bridge substructures. In measuring the justifiable expenditure for a first-class bridge substructure, due consideration must be given to the life and safety of the superstructure. A failing substructure is not only a failure in itself, but causes the superstructure to fail with it. Where a shortage of funds requires quality to be sacrificed in some portion of the bridge, the sacrifice had better be made in the superstructure, for while steel superstructures must continue to be some sort of expense for painting, deterioration, etc., a first-class concrete substructure closely approaches the structure in which the first cost is the only cost.

The Crystal Sand and Gravel Company of Battle Creek, Mich., is opening a 50 acre deposit of the finest gravel in the state of Michigan, estimated to contain not less than 5,000,000 yards. The other deposits in the vicinity are practically exhausted. This deposit is almost entirely free of impurities, and authorities state that the sand is of exceptional quality and will require 20 percent less cement than ordinary sand. Brick and blocks will be manufactured on the property. Steam shovels and washing plants are to be installed, and gravel and sand of different grades will be supplied. W. D. Ballou, formerly of Ballou Manufacturing Company of Belding, Mich., is president; J. B. Sperry, of Battle Creek, secretary and treasurer, and active manager.

The New Stone Crushing Plant of the Chicago Union Lime Works

The new crushing plant of the Chicago Union Lime Works, located at Nineteenth and Lincoln Streets, in one of the most thickly settled portions of the city, is of unusual interest on account of the many difficult engineering problems that had to be solved in its design and the unique manner in which many of the difficulties were overcome.

The Chicago Union Lime Works' quarry property embraces an entire city block, bounded on the north and south by Eighteenth and Nineteenth streets, respectively, and on the east and west by Lincoln and Robey streets. The quarry was first opened in 1859, at which time it was well outside the limits of the city of Chicago, but the growth of this city has been such that at the present date the property lies within one of

economical method devised by the J. C. Buckbee Company, engineers, of Chicago, who were retained by the Chicago Union Lime Works to design and supervise the construction of this entire work.

It was decided to use two yard, low-body, end-dump steel cars in the quarry, as the loading in the quarry is all done by hand, and to transport the stone in these cars to the plant, located on the surface. To raise the cars from the quarry level to the crusher floor level of the plant, some 290 feet, it was decided to install two cages, or what is more commonly known as platform elevators, operating in balance, so that the empty car would be going down while the loaded came up. It was further decided to install a steel framework resembling somewhat a bridge, set up on end and an-



Concrete Storage Bins at the Plant of the Chicago Union Lime Works.

the most congested portions of the town, being surrounded on all sides by large manufacturing plants, residences of the employees of these manufacturing plants and industries of every sort.

The quarry excavation occupies about one-half of the property, the balance of the property being devoted to lime kilns, crushing plant and yard purposes. The stone in this deposit is one of the best limestones occurring in the Chicago district, and is very homogeneous in structure, which has made it possible to carry the quarry walls down practically vertically. As a result of some fifty years' operations the depth of the quarry at the present time is 260 feet, while drillings have shown that good stone exists for a considerably greater depth.

One of the most difficult problems confronting the engineers upon building the new plant was, first, the devising of a means for raising the stone from the quarry to the crushing plant on the surface and, second, the installation of such apparatus as might be decided upon, as it was by no means an easy piece of work to attach any sort of a hoisting apparatus to a vertical quarry wall 260 feet in height. The problem was, however, very neatly solved, and at the same time a very

chored to the side wall of the quarry, for the cages to run in, and at first sight it seemed a very difficult job was in store in the erection of this steel framework. The problem, however, was very cleverly solved by J. J. Bassett, of the J. C. Buckbee Company, engineer in charge of the work, in the following manner:

A permanent steel tower, constituting the landing stage and support for the cable sheaves of this hoistway, was first erected, the upper section of the hoistway containing the two compartments for the cages, constituting an overhung portion of this tower. This tower rested upon a heavy concrete foundation, setting directly at the edge of the quarry, and the quarry face was cleaned and trimmed down to good solid stone by lowering men on a scaffold from the surface. The sections of the steel skipway were about ten feet in length, and these were all duplicates with the exception of the length of members extending back to the quarry face, which were made in each case to suit the quarry face. A platform was hung from the above mentioned overhanging portion of the tower, and the first of these sections set in place and riveted up, the members extending back to the rock face of quarry being let into

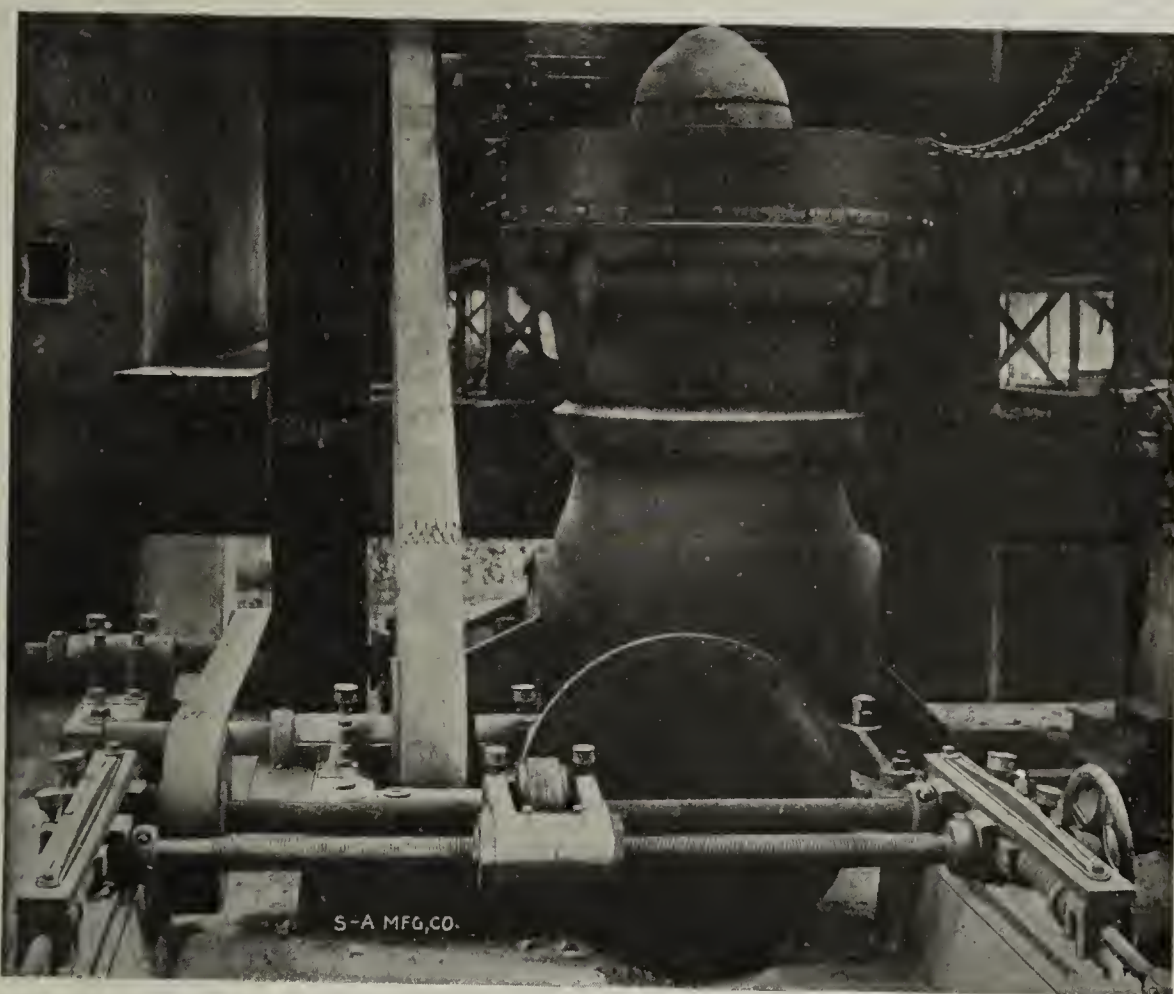
notches being cut in the quarry wall and then being concreted in place. The working platform was then lowered and hung from this first section and, the second put in place, being riveted up and the members extended to the quarry face, concreted as before and in a similar manner, the work was carried on until the quarry floor was reached, the steel all being lowered from the ground level and the work being carried on steadily and very rapidly.

A stairway was provided between the two cage compartments and the face of quarry wall for access to the quarry after completion, and the sections to this stairway were put in as each section of the skipway was completed, thus providing a ready means for reaching the work in progress at all times. The building of this skipway appeared at first to be a most hazardous job, but as worked out it became the most simple of jobs and was not attended with any unusual hazards at all, and it is a noteworthy fact to mention that there was no one injured in the slightest during any period of construction work.

ing screens are $\frac{3}{4}$ in. in diameter, and all stones smaller than this fall to two 48 in. x 96 in. shaking screens on the floor below which are provided with $\frac{1}{4}$ in. mesh screens and divide the stone into two sizes. Below the screens are the reinforced concrete storage bins, these bins being 40 feet in width by 45 feet in length and 26 feet in depth, and giving a total storage capacity of about 1,500 cubic yards. These bins are divided into twelve separate compartments and are supported upon reinforced concrete columns and girders and have running beneath them three roadways for loading wagons; the height in the clear of these roadways being 11 ft. 0 in.

All of the stone produced in this plant is hauled to destination in wagons and the same is loaded into the wagons by gates provided in the bottom of bins.

The oversize stone from the above mentioned revolving screens is conveyed by 16" special belt conveyors to the crusher end of building and discharged into a small, round steel bin 4 feet in diameter and 30 feet in height, which has at its lower end two openings, from



View of McCully Crusher in the New Crushed Stone Plant of Chicago Union Lime Works.

The loaded cars upon arriving at the crusher floor level, which is some thirty feet above the street level, are run on tracks a distance of about twenty feet into the main crusher building, where they run onto automatic tipples and dump the stone directly into a No. 8 McCully crusher. A large portion of the company's product is burnt lime, and the stone for this purpose is taken from the same quarry. There were, therefore, provided turntables in the hoisting tower between the above mentioned tipples and the cageways so that the cars filled with lime for the kilns could be diverted and taken to the kilns over a trestleway running out alongside of the crusher plant.

The No. 8 McCully crusher, mentioned above, sets upon a high concrete foundation so as to avoid pits under the elevators. The crusher breaks the stone to about $2\frac{1}{2}$ in. in size and the stone falls from the same to two No. 6 continuous bucket stone elevators, which raise the same to two 48 in. x 24 ft. revolving screens set over the storage bins, these screens being provided with perforations to give the sizes required by the Chicago market. The smallest perforations in the revolv-

which the stone flows into two No. 3 McCully crushers, which are set to break the same to about $1\frac{1}{4}$ " in size. The product of these crushers flows onto two 16" throughed belt conveyors set at a slight incline, which convey the same back to a point where it is discharged into the No. 6 elevators and thus raised again to the head of the plant for sizing.

The girders under the storage bins are 6 feet in depth, thus providing a tunnel under the bins, and in the two outside tunnels there are installed 16" special feeding conveyors, by which the stone from any of the bins can be taken back into the crusher building. These conveyors discharge directly into 42x16" crushing rolls and it is thus impossible to recrusher any size stone contained in the bins to a smaller size. The product of these rolls falls to the 16" belt conveyors mentioned above, which also serve the No. 3 crushers, and through these conveyors and the No. 6 elevators it is raised to the screens for sizing.

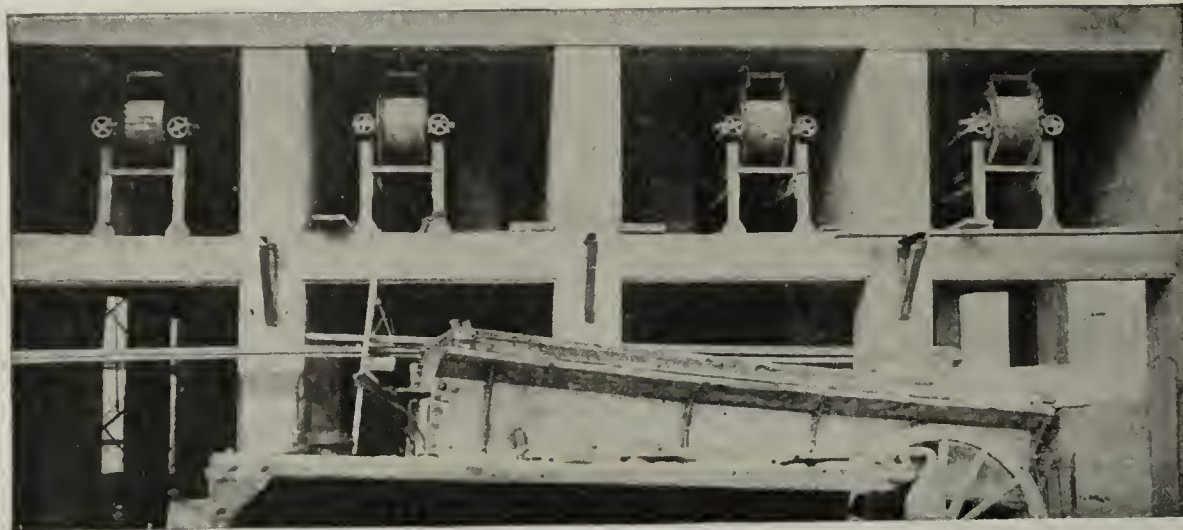
The No. 8 crusher is driven by its own 75 H. P. induction motor. Another 75 H. P. motor drives the two sets of crushing rolls, two No. 3 crushers and the

conveyors serving them, while a third 75 H. P. motor drives the revolving screens, shaking screens and elevators. The current for all of these motors being controlled from a switchboard located on the main crusher floor level adjacent to the hoist.

The most advantageous location of the plant for the utilization of the property available, as well as for the hauling of the stone away from the plant in wagons, was in a triangular strip of land bounded on one side

above the top of storage bins and the revolving screen floor 8 ft. 6 in. above this floor, and these two floors, together with their supporting structure and the outside walls, are of reinforced concrete. The balance of the structures of the plant are of steel, covered with corrugated iron.

Trolleys running upon "I" beams are provided over all of the crushing machines and other heavy machinery for use first in erection and later for making repairs,

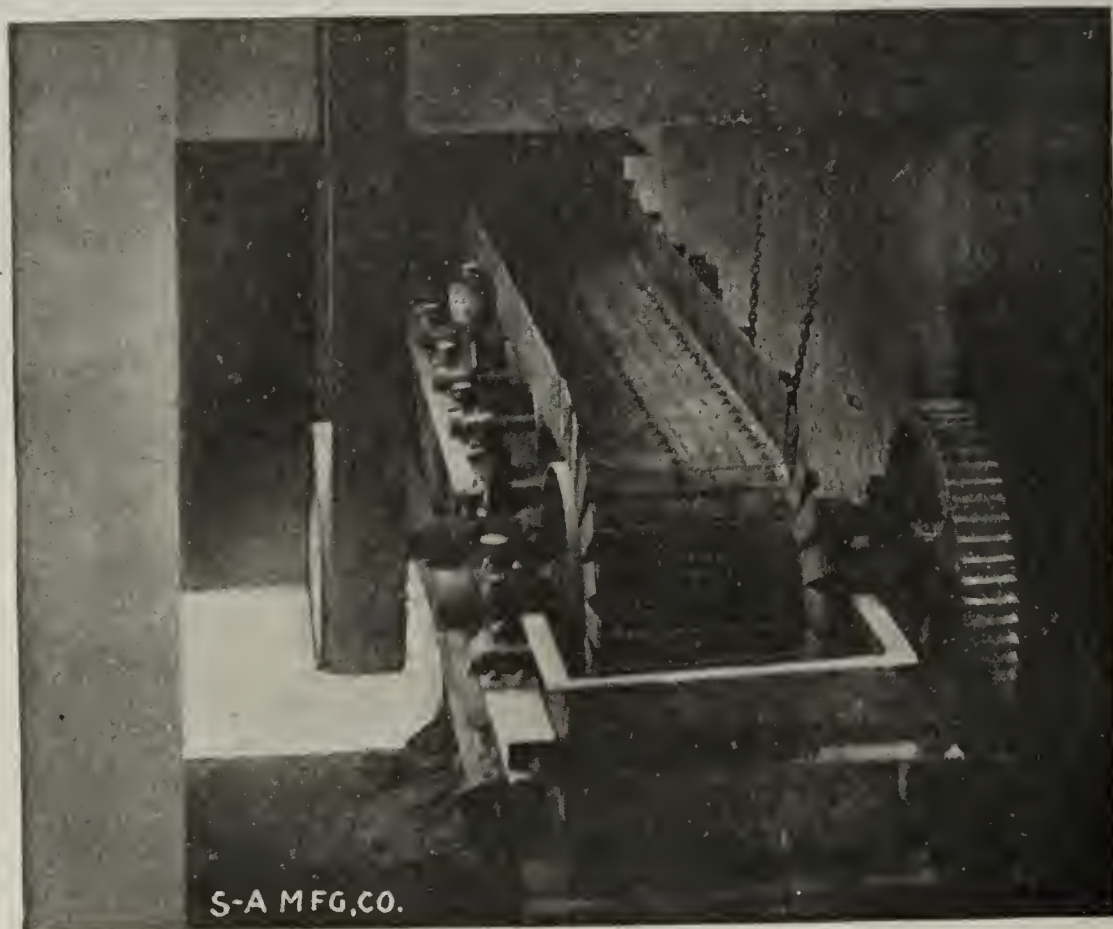


Rear Views of Four Conveyor Feeders.

by Wood street and on the other side by the quarry. This necessitated making the plant very narrow, and in order to get the machinery in, it was necessary to build the plant in several stories. The locating of the hoist for operating the cages of quarry was one of the most important problems, and this hoist was finally located on the crusher floor level, about 30 feet above the ground line and directly back of the crusher hopper. The providing of a proper foundation for the

and the entire plant, in spite of the fact that it is located in such a small piece of ground, is roomy and accessible in every particular, but is at the same time so compactly arranged as to require very few men for its operation.

The plant is electrically lighted throughout, so that the operations can be carried on at night as well as day. Necessarily a considerable amount of water is caught in the quarry during every rainstorm, and for



S-A MFG. CO.

Steel Pan Conveyor Feeder at the Chicago Union Lime Works.

hoist, for operating the cages of quarry was one of the most important problems, and this hoist was finally located on the crusher floor level, about 30 feet above the ground line and directly back of the crusher hopper. The providing of a proper foundation for the

As mentioned above, the storage bins are of reinforced concrete. The shaking screen floor is 9 feet

removing this there is provided a multi-stage centrifugal pump in the quarry, which discharges the water through a pipe line placed alongside of the skipway and terminating in the city sewer at street level. Compressed air for operating the quarry drills is furnished by an electrically driven air compressor located in a steel building alongside of the hoisting tower of the crushing plant.

Plans on this plant were commenced in July, 1909,

construction work being started in November of the same year, but not pushed to any extent, as it was not desired to have the plant completed until late in 1910, as the old crushing plant was easily good for another year's service. The plant was completed and placed in operation in August, 1910, and has since been operated to capacity.

All of the concrete work was done under contract by the Pleas Concrete Construction Company, the steel structures were furnished and erected by the Kenwood Bridge Company, while the corrugated iron work was done by H. C. Knisley Co. The No. 8 crusher, elevators, crushing rolls and screens were furnished by the Power & Mining Machinery Company. The electric hoist for the cage-way, all of the motors of the plant and the multi-stage centrifugal pump were furnished by the Allis-Chalmers Company. All of the conveyors, shafting and pulleys, variable speed devices and bin gates were supplied by the Stephens-Adamson Mfg. Co., of Aurora, Ill. The cages were furnished by the Kilbourne & Jacobs Mfg. Co., of Columbus, Ohio, and the quarry cars by the Orenstein Arthur Koppel Co.

MESTA GAS ENGINE.

The modern Horizontal, Double-Acting, Four-Cycle is fully as reliable as a Corliss steam engine or a steam type of prime mover can equal the Gas Engine.

The Mesta Gas Engine is the result of a careful turbine. From an economical stand point, no other study of the gas engine question for a number of years, both in this country and abroad. While it does not differ widely from several other makes of modern Horizontal, Double-Acting, Four-Cycle Gas Engines, it has some features which are not found in any of the other engines. A description of these features will be found in the catalogue of the Mesta Machine Co., of Pittsburgh, Pa.

The skill required to operate a modern Gas Engine is no more than is required for a steam engine. From actual records it has been shown that the Mesta Gas Engine can be started and will take full load in less time than is required for a steam engine. The repairs are no more, while the fuel cost is less than one-half of that required by the steam engine or steam turbine to produce the same power.

The Mesta Machine Company do not build what are termed small Gas Engines, their smallest engine being about 400 horse-power, but they build all sizes from that up to the largest engines used. Their large and well equipped shops and long experience in building steam engines of the largest units for the heaviest work, such as are required in the iron and steel works in this country, place them in an excellent position for building large Gas Engines.

CONCRETE FENCE POSTS.

"The tests, observations and use of concrete fence posts during the current year indicate that concrete fence posts are practical, durable and economical."

This is a part of the finding of the Committee on Signs, Fences and Crossings of the American Railway Engineering and Maintenance of Way Association and is to be incorporated into their Manual of Recommended Practice.

The railroads, as a rule, adopt a standard only after they are absolutely sure it is what they want, and from the above it may safely be assumed that their use of concrete fence posts will rapidly increase.

The farmer is already using concrete fence posts

extensively, and this formal endorsement by the railway men shows that he is on the right track.

BIDS FOR CEMENT.

The Cement Testing Section, of the United States Reclamation Service with offices at Denver, Colorado, inspected at factories and shipped to various projects during the month, 4,500 barrels of cement. Miscellaneous work was carried on during the month, including the continuation of permeability and sand-cement test for the Arrowrock dam on the Boise Project. On April 3, proposals were opened for 130,000 barrels of cement. An abstract of the bids received is printed below. Informal proposals were also received from the Riverside Portland Cement Company, Riverside, California, for furnishing cement at \$1.40 per barrel, f. o. b. Riverside California, and from the Colorado Portland Cement Company of Portland, Colorado, for furnishing cement at \$0.96 per barrel, f. o. b. Portland, Colorado, for delivery in Arizona, Idaho, Nevada, Utah, Wyoming and South Dakota. Abstract of bids for cement.

Ash Grove Lime and Portland Cement Co., Chanute, Kansas, \$0.90 per barrel; Atlas Portland Cement Co., Hannibal, Mo., \$0.95 per barrel; Colorado Portland Cement Co., Portland, Colo., \$1.15 per barrel; Henry Cowell Lime and Cement Co., Bay Point, Cal., \$1.24 per barrel; Dewey Portland Cement Co., Dewey Okla., \$0.83 per barrel; Iola Portland Cement Co., Iola, Kansas, \$0.80 per barrel; Marquette Cement Manufacturing Co., La Salle or Oglesby, Ill., \$1.10 per barrel; Pacific Portland Cement Co., Tolenas, Cal., \$1.32 per barrel; Portland Cement Co., of Utah, Salt Lake City, Utah, \$1.50 per barrel; Santa Cruz Portland Cement Co., Davenport, Cal., \$1.40; Southwestern Portland Cement Co., Courchesne, Texas, \$1.37 per barrel; Standard Portland Cement Corp., Napa Junction, Cal., \$1.40 per barrel; Superior Portland Cement Co., Concrete, Wash., \$1.55 per barrel; Three Forks Portland Cement Co., Trident, Mont., \$1.18 per barrel; Union Portland Cement Co., Devil's Slide, Utah, \$1.30 per barrel; United Kansas Portland Cement Co., Iola or Independence, Kansas, \$0.80 per barrel; Universal Portland Cement Co., South Chicago, Ill., or Buffington, Ind., \$1.05 per barrel; U. S. Portland Cement Co., Yocemento, Kansas, \$1.00 per barrel; Washington Portland Cement Co., Concrete, Wash., \$1.55 per barrel.

A new cement tile machine has been installed at the cement factory of Roscoe & Carlson, at Shenandoah, Iowa, and is now in operation. It is the latest model and has a capacity of five tile a minute or three thousand a day.

DUSTPROOF BAGS WANTED.

Counsul-General John P. Bray, Sydney, Australia, writes that differences have arisen between the local cement manufacturers and the wharf laborers at Sydney over handling cement in bags, the laborers claiming that the dust from the bags injures their health. The wharf laborers have virtually refused to handle bagged cement, which seriously hampers the trade.

The output of the leading cement plant is about 36,000 bags per week. They are now shipping the cement in cloth bags lined with paper, but the method is so costly as to be almost prohibitive. The consul suggested that some manufacturers of paper bags in the United States correspond with the company in question. The address of this company can be secured from the Bureau of Manufactures, Washington, D. C.

The History and Manufacture of Manganese Steel

Has Proven to Be the Best Metal so Far Produced Where Resistance to an Abrasive Action is Required.

By G. W. Kneisly

A composition, the chief elements of which are iron and carbon, composes the major portion of the steel made in the world to day, but each year shows a increase in the tonnage of steel resulting from the mixture of iron, carbon and one or more of the following elements: Manganese, nickel, chromium, titanium, tungsten and vanadium. Of these alloy steels, as the product of the various mixtures is termed, manganese steel is by far the most important.

Manganese is best known to the iron trade as "ferro manganese," a compound containing about 80 per cent of the element manganese. The ore from which ferro manganese is made is mined chiefly in Russia. Through the use of sufficient ferro manganese to produce a steel having a manganese content of 11 to 13½ per cent., with the other ingredients as they should be, a wonderful quality of metal is produced; not, however, until the castings have been subjected to a most careful and thorough heat treatment for the purpose of imparting to them the high degree of toughness for which manganese castings are noted wherever used.

For several reasons the cost of manufacturing manganese steel castings is higher than either steel or iron castings; for instance:

The melting stock costs more. The ferro manganese used is expensive.

The molding and coremaking require more care and a higher degree of skill in their preparation, for manganese castings being so extremely hard and tough, cannot economically be altered in shape, once they are made.

Nearly all molds must be dried in an oven before pouring, and all castings must be heat-treated—both of which processes call for the operation and upkeep of expensive furnaces.

In the cleaning or fettling room, where the fins, gates and cores are removed from the castings there must be installed every conceivable type of grinding apparatus.

Manufacturers of manganese steel realize that on account of the fact that manganese steel castings are practically non-machinable, they must leave the plant in a condition to be placed in service in crushers or other machines without further labor upon them.

Manganese steel has been successfully manufactured for about twenty-two years. The problem was first solved by R. A. Hadfield, of Sheffield, England.

Manganese steel was first made in the United States about sixteen years ago. Out of the large number of those who have attempted its manufacture in the United States only five or six have been successful owing largely to the limited knowledge of all the features to be dealt with in connection with each step throughout the process.

Specialists of the highest order and a large equipment of specially constructed grinding machinery are essentials.

Experience in the use of the metal shows it to be the best so far produced where resistance to an abrasive action is required. One of the first uses of manganese steel castings was in dredge pins. From observation of the life of these pins in dredges the owners of steam shovels asked if they could not secure some benefit if they were to use the material for the lips and teeth of their dipper. It was tried and the results were such that every shovel working on the greatest engineering feat of the age—the Panama Canal—is equipped with manganese steel dipper teeth, dipper lip, latch, latch-keeper, racks and pinions.

Noting the success with which they were meeting in dredge and steam-shovel work, the makers of this alloy steel began to look for other places where a material which could be neither drilled nor machined could be used. The rock crushers were wearing out jaw plates all the time. The new steel was tried. Everywhere they found that it earned more than its cost, giving from four to six times the service that chilled iron had been giving and in addition that the operator was ahead the time and cost of making frequent changes. But the mental relief resulting from a knowledge that the plant will keep going is a benefit that cannot be capitalized. At Berlin, Wis., the Berlin rhyolite is being crushed. This is the hardest rock in this country that is being crushed in large amounts. In a No. 6 gyratory crusher the operators obtained an average service of one thousand and nine cubic yards of rock from five sets of chilled iron concaves. One set of manganese steel concaves gave them four thousand sixty-three cubic yards of the same stone, or four times as much.

Companies crushing rock and ore all over the country have adopted manganese steel for their jaw plates and in many instances for their roll shells. Many of these companies had their own iron foundry, but tests which they made showed conclusively that the use of this special alloy steel was more economical than to make their own chilled iron castings.

A large amount of the manganese steel which is cast goes into burglar-proof bank safes.

Drilling tests on this steel have shown that it is impossible to secure any appreciable penetration with a machine drill in the very best equipped shops, therefore, the burglar with a small hand drill stands no chance of drilling a hole in a manganese steel safe.

Finding that an alloy of manganese and steel gave them a material which was very resistant to any abrasive action, and which also had great strength, the alloy steel manufacturers began to look for other places where this steel could be used.

Railroad crossings and frogs had up to this time been made of Bessemer rails, planed, bolted together and reinforced. The steel makers advanced manganese steel to the operators of the various railroads, suggesting that the crossings be cast in two or four parts and then joined with splice bars, making a solid manganese



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crossing with few bolts to work loose. Solid manganese steel frogs were also made and tested in the most severe places. The results of these tests were truly astonishing.

Subjected to the same service manganese steel frogs may safely be expected to wear as long as eight to ten Bessemer frogs. In some instances they have been known to outwear twenty-six Bessemer frogs of the usual built-up type. It is a significant fact that the railroad companies who have had the longest experience with manganese steel track work are the ones who are today extending their purchase of it, despite the increased initial cost, conclusively showing that its added efficiency is unmistakably manifest.

Different grades of manganese steel were cast and tried out in the tracks of various railroad companies. Careful records of the service given by the castings produced from different mixtures were kept and as the makers noted the requirements of service and regulated the quality of their product according with the result that the service tests proved most gratifying to users and makers, showing up some very remarkable performances.

A great deal of money has been saved by various steel mills, cement mills, brick manufacturers, steam shovel manufacturers and others through the use of manganese steel gears, pinions and racks.

At first it was considered impracticable to use this metal in gearing on account of the difficulty to be encountered in the boring and key-seating of the hub.

The remedy was found in the use of a soft steel bushing which is placed in the mold after the manner of "setting" a hub core. The manganese steel is then poured around it, firmly anchoring the bushing in its place, when the boring and key-seating may readily be accomplished.

One large steel rolling mill writes as follows regarding manganese steel gears.

"We have found that the wearing qualities are excellent and the indications are that they will last from four to five times as long as the ordinary steel casting."

Practically all of the larger steel works of this country are using quantities of manganese steel gears, and the fact that they are placing orders for more shows that they believe in their economy.

Reports as to the life of manganese steel sheave-wheels compared with those made of other metals, show a greater life as applied to both the sheave wheel and the rope. This is accounted for in the following way:

When a cast steel or iron sheave wheel is used with a wire cable the latter is continuously cutting tiny sharp particles off the inner sides of the sheave wheel flanges.

These become imbedded between the strands of the cable, eventually cutting many of the strands, resulting in the failure of the cable.

A proper question at this point would be. "Will the manganese steel sheave wheel, being hard, wear the cable quickly?" It will not, owing to the great difference in the relative texture of the two metals. The friction between the two is much less, and the grove in the sheave wheel quickly wears smooth and glazed.

The aim of the up-to-date cement manufacturers seems to be "permanent equipment" in all possible places about the plant. Loss of output is a serious matter.

Grinding plates and breast plates for ball mills, gearing of all kinds, conveyor parts and many other of manganese steel have been extensively adopted.

We are now making 30 huge manganese steel gear rings weighing about three and one-half tons each, to

be placed upon a like number of tube mills soon to be installed in one of the largest cement plants in the United States. This order was the result of successful showing made by manganese steel gears, which had previously been subjected to severe tests in the same plant.

A cement plant working in the Middle West is using a hammer pulverizer on hard limestone. The superintendent reported that while tempered tool steel used in the swing hammers had given a life of four hundred and fifty hours, manganese steel hammers on the same raw material gave a life of seventeen hundred hours.

CRACKING OF CEMENT-GROUTED BRICK PAVEMENTS: CAUSES AND REMEDIES.

By Earle R. Whitmore.

The following are the causes of cracks in brick or block pavements which the writer has observed; and they are placed, he believes, in the order of their importance and frequency of occurrence, and will be discussed separately in that order:

- (1) Frost.
- (2) Expansion.
- (3) Settling of sand cushion.
- (4) Settling of sub-grade.
- (5) Contraction between transverse expansion joints.

The writer fully appreciates the fact that this is not the order of precedence in which these causes of failure would be placed on information obtained from the preponderance of technical literature on the subject, but believes that careful observation will prove it to be the correct arrangement, nevertheless.

Frost.

The writer's observations seem to him to prove beyond doubt that the longitudinal crack along the crown of the pavement (or sometimes several feet to one side of the crown) are nearly always, if not always, caused by frost. This is the cause which the average layman usually assigns, and perhaps that is the reason that the average engineer, in his assumption of wisdom, is convinced that it is the wrong solution.

The following observations support the layman's theory:

(a) These longitudinal cracks invariably first appear in the form of a very small and insignificant appearing crack, when the snow goes off in the spring.

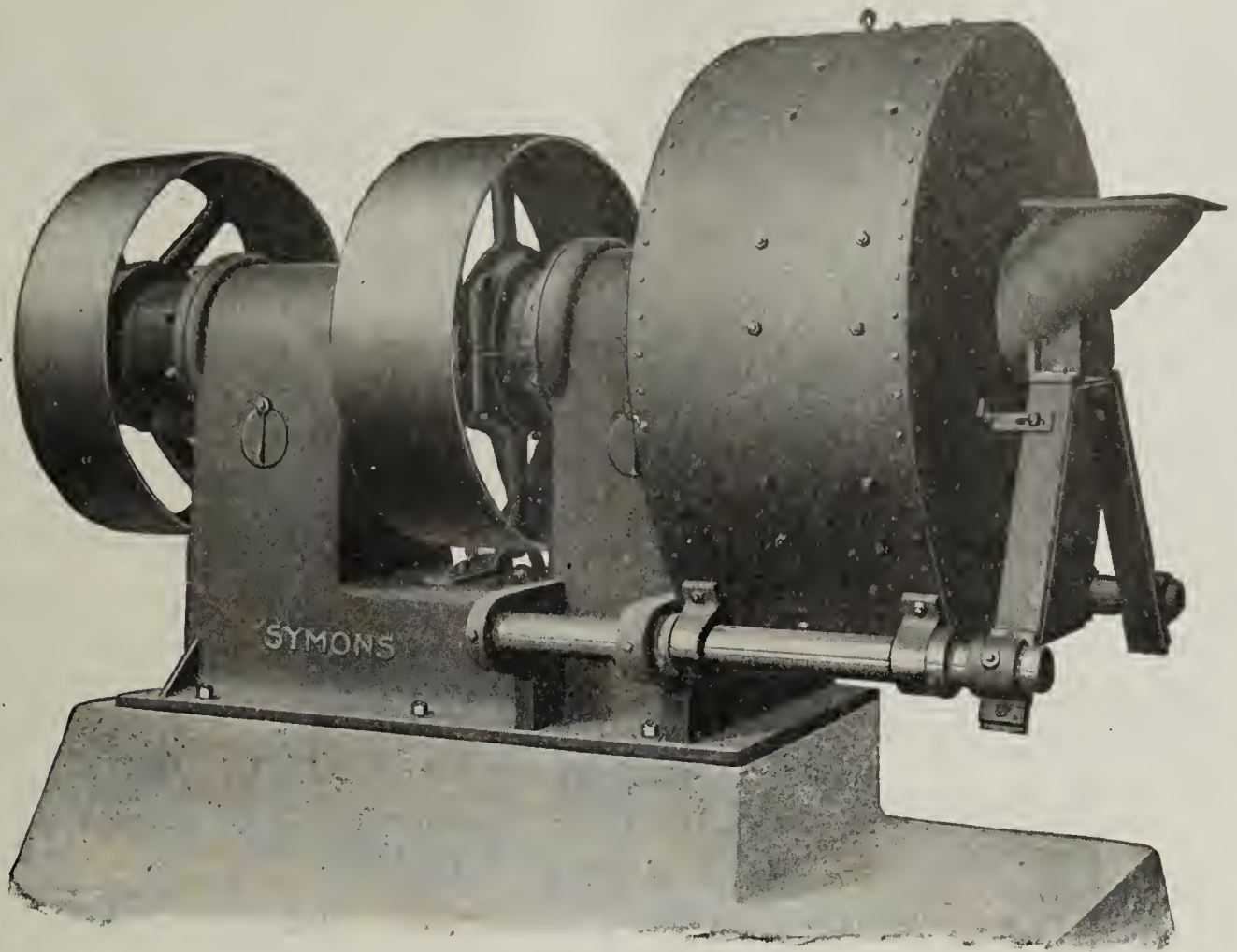
(b) Where the sub-soil is clay, the cracks are found where ample expansion joints are provided next to the curb, as well as where there are no expansion joints.

(c) Where the sub-soil is sand, or on fills where there is good natural drainage, these cracks are "conspicuous by their absence," even where there are no expansion cushions.

(d) The cracks follow along the line of travel on the street (usually near the crown), where the snow is packed by traffic during the winter and the frost penetrates deepest. Where there are one or more car tracks on the street, there is usually a crack along the driveway each side of the tracks, if the sub-soil is impermeable clay or of such a nature as to retain water. At intersecting streets which cross the paved street, the crack does not continue across the intersection (presumably because the travel across the street and around the corners packs the snow and permits the frost to penetrate over sufficient area to raise the pavement uniformly without breaking it); but where the intersecting street comes in from one side only, the crack runs off toward the opposite curb as it approaches the intersection, and continues across the intersection, coming back to the crown again on the other side.

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TABLE OF WEIGHTS AND CAPACITIES FOR SYMONS DISC CRUSHERS

Size of Crusher.....	48-in.	36-in.	24-in.	18-in.	13-in.
Approx. Shipping Wt.....	30,000	19,000	8,500	5,600	3,000
Opening in Elliptical Feed Spout	11 $\frac{1}{4}$ x 17	9 $\frac{1}{4}$ x 14 $\frac{1}{2}$	7 x 10 $\frac{3}{8}$	4 $\frac{3}{4}$ x 7	4 x 4 $\frac{1}{2}$
Opening between discs at feed spout	8-in.	5-in.	3 $\frac{1}{4}$ -in.	2 $\frac{1}{4}$ -in.	1 $\frac{3}{4}$ -in.
Min. exit opening for best results	1-in.	$\frac{3}{4}$ -in.	$\frac{1}{2}$ -in.	$\frac{3}{8}$ -in.	$\frac{1}{4}$ -in.
	Size of Ring Tons per Hour	Size of Ring Tons per Hour	Size of Ring Tons per Hour	Size of Ring Tons per Hour	Size of Ring Tons per Hour
Cap. in tons per hour.....	1 = 45-60 1 $\frac{1}{2}$ = 60-75 2 = 75-80 2 $\frac{1}{2}$ = 85-100	$\frac{3}{4}$ = 25-30 1 = 30-40 1 $\frac{1}{2}$ = 40-50 2 = 50-60	$\frac{1}{2}$ = 12-15 $\frac{3}{4}$ = 18-20 1 = 20-25 1 $\frac{1}{2}$ = 25-30	$\frac{3}{8}$ = 5-8 $\frac{1}{2}$ = 8-10 $\frac{3}{4}$ = 10-12 1 = 12-15	$\frac{1}{4}$ = 4-5 $\frac{3}{8}$ = 5-7 $\frac{1}{2}$ = 6-8 $\frac{3}{4}$ = 8-10
R. P. M. Main Pulley	100	133	150	200	300
R. P. M. Eccentric Pulley	200	266	400	450	600
Size of Pulleys	54 x 16	44 x 14	34 x 10	28 x 8	20 x 6
H. P. required	50-65	30-40	18-25	12-18	10-15

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(e) A careful examination of the concrete foundation under the longitudinal crack will reveal the fact that the foundation is also cracked.

Is this expansion? And yet the specifications of the National Brick Manufacturers' Association, admirable and complete in most respects, make no provision for drainage except the statement that:

if the ground is spouty clay, tile drainage should be provided to carry off the accumulation of wet; and even this meager suggestion is modified by the statement that:

Underdrainage is not absolutely essential, but in wet and spouty clay understratum much is added to the durability of the structure by keeping the sub-foundation dry.

No mention of frost. The report of the Asphalt Committee of the Organization for Standardizing Paving Specification provides for drainage:

when the soil is of such a character that it retains an excessive amount of moisture, such as clays subject to swelling or heaving under the action of frost;

but the report of the Brick Committee makes no mention of underdrainage. Technical books also are uniformly vague on this subject, and the inexperienced engineer has little indeed to warn him of the danger of frost.

Inasmuch as it is an established fact that frost has no tendency to swell or heave any kind of soil from which the moisture is thoroughly drained, the writer ventures the opinion that the best way to prevent this form of cracking is to provide a suitable drain under each curb where the subsoil is clay, and connect same with sewer inlets. Such drains should be placed about 3 ft. below the top of the curb, and the trench over the drain filled up to the bottom of the curb with coarse material, such as cinders or small fieldstone.

Placing cross-drains under the pavement is probably to be discouraged, as water cannot penetrate through the pavement after it is once built, and there seems to be little necessity for making provision for carrying water from the middle of the pavement toward the curbs; and these cross-drains tend to carry water under the pavement during the wet season, where it may percolate through the sub-grade, rather than to remove it.

Too shallow side-drains are also to be guarded against.

The writer does not consider his observations sufficiently final to warrant the omission of expansion cushions next the curb, in view of the fact that all modern paving specifications require such expansion cushions. His personal opinion, however, is that they seldom if ever serve any useful purpose except on very wide pavements. It is undeniably true that after the crack is once started it continues to widen from the action of alternate expansion and contraction; but I have never seen a crack of this kind that appeared to have been caused by expansion originally.

Expansion.

Expansion cracks occur on a hot day in summer, usually at a crown in the longitudinal grade of the paved street, when several courses of brick are sometimes thrown into the air with considerable violence, and when the repair gang comes to relay them they find that there is at least one row of the blocks which were thrown out that cannot be relaid.

This form of cracking is quite spectacular, and furnishes exceptional opportunities for advertisers of bituminous fillers. At the same time the damage to the pavement is comparatively slight and easily repaired.

Where there is no abrupt change of grade to permit the pavement to buckle, the observations of the writer

seem to indicate that the filler between the brick courses is sometimes crushed in places, and the surface cracked into diamond-shaped or triangular divisions, the cracks following the joints and seldom breaking a brick. If there is a bend or angle in the paved street, the effect of expansion will be carried to this point of weakness and will shove the angle considerably out of line.

The specifications of the National Brick Manufacturers' Association provide expansion cushions along the curbs only—no transverse joints. The report of the Brick and Granite Block Committee of the Organization of Standardizing Paving Specifications also provides for longitudinal expansion joints only, being practically copied from the specifications of the National Brick Manufacturers' Association. I understand that the secretary of the association, Mr. Will P. Blair, maintains that the longitudinal expansion, failing to find room to act longitudinally, is in some mysterious manner transformed into transverse expansion, and is then taken care of by the side cushions. This may be true to the extent that the breaking of the surface into diamond-shaped or triangular areas probably has a tendency to force the brick apart and outward toward the curb to some extent; but this is taking care of the expansion after it has done its damage.

These diagonal cracks, zigzagging along the brick joints, are inconspicuous, and in fact are often not visible except at such times as foggy mornings, when each crack is outlined by a line of moisture. They are not conspicuous like the longitudinal crack caused by frost, and make no spectacular explosion like the failure by buckling of the paved surface; but they extend over the whole surface of the pavement, tending to destroy its waterproof condition, and forming starting points for the jar of heavy traffic to begin its destructive action; and no doubt shorten the life of the pavement much more than the widely advertised buckling, which is all in one place and easily repaired.

It is believed that the most logical method of preventing this form of failure is to provide frequent transverse expansion joints, and that these joints are best formed by laying several courses of brick about one-fourth inch apart and filling these quarter-inch joints with a suitable bituminous filler before grouting the balance of the pavement.

The use of single expansion joints one-half inch or more in width is to be condemned for several reasons; it makes a bump for loaded vehicles, causing a hammering action on the adjoining brick which soon loosens them, and the fault thus started spreads rapidly under traffic; the bituminous filler is very apt to run in a wide joint, from the crown toward the curbs, in warm weather; the expansion sometimes forces the bottoms of the blocks next the expansion joint together, while the tops are held apart by earth, etc., which has become packed into the joint, causing the brick to heave up next the joint.

Settling of Sand Cushion.

This occurs from several sub-causes:

(a) If the sand cushion is spread on a macadam foundation, it is apt to work down into the foundation in places and cause unequal settlement, thereby breaking the paved surface. One or two cities, at least, have had disastrous results from attempting to lay brick pavements on macadam foundation in this manner. It could probably be avoided by filling and rolling the macadam foundation in about the same manner as for a finished macadam pavement, but there would usually be no economy in that. It is believed that a good concrete foundation is the most economical in

the long run, unless possibly under some very exceptional conditions.

(b) If sufficient care is not exercised in forming the surface of the concrete foundation parallel with the plane of the required pavement surface, the sand cushion will be of varying thickness, and therefore liable to settle unevenly.

(c) The foundation having been properly laid, if the cushion is carelessly footed it will still be of unequal thickness; or if spread with a templet, and the templet is not carried back and drawn over the surface several times, the surface will invariably be wavy and cushion of unequal thickness.

It is a serious mistake to leave the sand cushion uneven, depending on the rolling to level it. The roller will probably make it appear quite level, but some of the blocks will be well bedded while others

will have received practically no benefit from the rolling, and these will naturally settle later under traffic.

(d) If the sand is partly dry and partly moist when spread, it will naturally settle unevenly. If the sand were all uniformly moist, the settlement would perhaps be as uniform as though dry sand were used; but a pile of sand is often dry on the outside and damp inside, or vice versa, and may not be thoroughly mixed in spreading. When such sand is used it should be dried, or if it were moistened uniformly by sprinkling the same purpose might be served.

Cracks caused by settling of sand cushion are usually roughly rectangular, do not break across the bricks, and the inclosed rectangle drops below the balance of the pavement. These rectangles vary in size from two or three bricks to several square yards. They go down under traffic sufficiently heavy to break the bond

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of the grout, and if the bond does not break an arch is formed, giving rise to the rumbling noise so often complained of. If not repaired at once the fault spreads rapidly, under the hammering action of traffic, over the surface of the adjoining pavement.

The proper thickness of the sand cushion has been the subject of much discussion. The writer believes that any thickness from 1 to 2 ins. is all right, if properly applied. Some have claimed that a mortar-bed in place of the sand cushion is the panacea for all these difficulties; it is probable that a mortar-bed properly prepared would give satisfactory results, as it has been extensively and successfully used for creosoted wood block pavements. The sand cushion is probably equally good, or better, if carefully and properly handled.

Settling of Sub-Grade.

This form of failure is also due to various sub-causes:

Pavements laid across fills are very apt to settle. It is only with the greatest care that a fill can be made so that it will not settle more or less.

Improperly-filled trenches for sewer, water and gas pipes, etc., often cause settlement many years after the pavement is laid. The pavement arch is strong enough, perhaps, but as the earth from the sides of the trench is gradually jarred down the span widens until it becomes too broad to support the load of traffic. Too great care can hardly be exercised in properly back-filling such trenches.

Very wet and undrained sub-grade sometimes is the cause of this trouble. Suitable side drains would usually remedy the matter when moisture is the cause.

Contraction Between Transverse Expansion Joints.

When expansion joints are placed a considerable distance apart, it is noted that fine cracks appear at in-

tervals, following the grouted joint from curb to curb. Where expansion joints are 50 ft. apart two such cracks appear in the 50 ft., dividing the pavement into sections about one rod in length. These cracks are hardly noticeable, and sometimes can only be observed at certain times when outlined by moisture.

It is believed that they should be obviated by placing the transverse expansion joints only about 15 ft. or a rod apart. It would then be necessary to fill only one or two joints with the bituminous filler at each place.

INCREASING USE OF CONCRETE.

Very extensive irrigation works are now under way in different parts of Australia, and in several instances concrete dams of immense height are being built for impounding the waters. In New South Wales 50,000 tons of cement are being used in the construction of the Barren Jack dam. The height of this dam is 240 ft. length of crest 784 ft. thickness at base 170 ft. and at crest 18 ft. Another great dam which will likely soon be built to increase the water supply of the city of Sydney, as well as for irrigation purposes, will, if constructed as proposed, have a height of 275 ft. and be one of the highest concrete dams in the world.

For ordinary building purposes the local use of concrete is being stimulated by increasing popular knowledge of its advantages and by increasing cost of timber. There is great activity in building at Sydney and other leading cities in Australia, due to the prosperity of the country arising from a succession of good years for the primary industries of sheep raising and wheat growing, which have caused "boom" times in every branch of business. It is stated that contracts for new buildings in Sydney alone amounted last year to about \$30,000,000.

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CHICAGO, AUGUST, 1911

CEMENT TILE.

The latest efforts of cement manufacturers and users have been towards improving the conditions existing in the cement tile industry.

It has long been recognized that the cement tile manufacturer can resist successfully the attacks on the part of the clay tile producer only by leading an active campaign with a view to educating its members to produce nothing but first-class tile. As long as improperly made and insufficiently cured cement tile were placed on the market, it was evident that the clay tile manufacturer could renew his criticism and point out cases in which cement tile failed. This, of course, would hurt the trade of the manufacturer of high-grade cement tile as well as that of the producer of inferior goods.

A standardization of the methods of manufacture and of testing the finished product was, therefore, decided upon as the first and most important step towards keeping up the reputation which manufacturers of well-made cement tile had established.

All parties interested in the outcome of the work have been busily engaged for some time in contributing their share to the final solution of the problem.

The Portland cement manufacturer, who supplies the most important raw material for making cement tile, put his experts to work to investigate the subject thoroughly. University experiment stations were called upon next in order to act as arbitrators and to test both clay tile and cement tile. The result of their efforts was a number of reports on researches covering every phase of the subject, including proposals for standard methods of making, curing and testing cement tile.

At the same time, the manufacturer of cement tile machinery improved the process of making cement tile so much that a reliable cement tile can easily be obtained, at a fair profit, by any one who works honestly and desires his goods to become a credit to the industry.

Thus, by combined efforts, the cement tile industry bids well to increase rapidly in the same way as all other branches of the cement industry have grown wonderfully from the time standard rules were laid down as a protection against unfair competition and as a safeguard for the purchaser and consumer of the manufactured article.

SAND-LIME PRODUCTS.

By E. Leduc & Ch. de la Roche.

(Continued from page 234.)

Proper Amount of Water: The question how to mould a sand-lime mixture, dry or rather plastic, has frequently been discussed. It was, therefore, of interest to us to determine the most favorable conditions under which the mixture could be compressed.

In order to decide this problem, we prepared a number of series of tests in which we varied the sand, the percentage of lime and of water in the mixture, the initial pressure in moulding the cylinders and also the steam pressure. The lime used for all these tests was pure hydrated lime.

Table XXII contains the results of these experiments.

These tests show that, for the low percentage of hydrated lime used in the manufacture on a large scale, the amount of water to be added to the sand-lime mixture has to be very small. With an admixture of 5 per cent of water a sand-lime mixture containing 88 per cent of sand and 12 per cent of hydrated lime proved to be sound upon being hardened, whereas an additional 2 per cent of water caused half of the test cylinders to lose their cohesion. (See test "a.") A further increase of 2 per cent of water made all test cylinders disintegrate in the hardening cylinder (see tests "b," "c" and "d," "e"). Many failures in manufacturing sand-lime brick are undoubtedly due to a faulty regulation of the amount of water added to the sand-lime mixture.

In practical operation, disintegrating of the brick during the hardening process can be observed frequently, especially in winter when the sand is very moist.

In the case of test cylinders containing 20 per cent of hydrated lime, the percentage of water could safely be varied within wider limits; also the strength did not decrease as rapidly with varying amounts of water. However, sand-lime brick containing 20 per cent of hydrated lime can not be manufactured on a large scale, because the cost of production would be too high.

Table XXII teaches, furthermore, that sand-lime mixtures containing crushed sharp-cornered sand grains yield far superior results to those made with sand composed of round grains (sand from Fontainebleau).

Effect of Drying-Out of the Sand-Lime Mixture Before Hardening.

It happens frequently that, owing to faulty mechanical installation or for some other reason, the cars loaded with pressed unhardened sand-lime brick wait in front of the hardening cylinder for a whole day or night before they are subjected to steam-pressure. This experience suggested the necessity of investigating, whether or not partial drying-out prior to hardening would affect the ultimate strength of the hardened product.

At the same time it was of interest to test, if the brick placed into the hardening cylinder first possessed the same strength as those put in last, because at many factories the first carload of brick leaves the press about ten hours earlier than the last.

In order to throw light upon this subject, we made three series of test cylinders with pure lime and three with hydraulic lime.

The first of these three sets of test pieces of each kind were kept for twenty-four hours in hermetically sealed glass jars. After twenty-four hours the lid was opened a little so that the test pieces destined for forty-eight hours and one week could dry out slightly. Hence, during the first twenty-four hours the test pieces could not possibly have lost any water.

all (hardened after having been kept in a sealed jar for twenty-four hours). Those partly dried out (hardened after forty-eight hours) possessed lower strength, namely 1,590 lbs. against 1,835 lbs. The test pieces dried out for a week showed still lower resistance, namely 1,525 lbs.

The test cylinders, which were exposed to the air of the laboratory room for twenty-four hours, have given practically the same results as those kept in sealed jars for the same length of time.

The specimens made with hydraulic lime show a considerable decrease in strength, if hardened only a week after having been moulded; this, of course, is readily explained by a partial setting of the hydraulic lime prior to the exposure to steam.

TABLE XXII.

EFFECT OF VARYING PERCENTAGES OF WATER IN THE SAND-LIME MIXTURE, AND OF THE NATURE OF THE SAND UPON THE STRENGTH OF THE HARDENED PRODUCT.

Nature of the Sand.	Lime per cent	Sand per cent	Initial Compression of mixture lbs.	Steam Pressure lbs.	Time of Exposure to Steam Hours	Water added to Sand-Lime Mixture. per cent	Resistance to Compression after hardening in lbs. per sq. in.				Average.
Sand from Fontainebleau.	20	80	11.250	150	6	5	4.650	4.500	4.500	4.425	4.518
	"	"	"	"	"	7	4.125	4.575	4.912	4.500	4.530
	"	"	"	"	"	9	3.825	3.900	3.900	4.050	3.918
	"	"	"	"	"	11	4.125	3.938	3.750	3.450	3.817
	"	"	"	"	"	13	3.825	3.712	3.975	3.825	3.832
Sand from Leucate, crushed and passed through 40-mesh sieve	"	"	"	"	"	15	3.750	3.600	3.825	3.600	3.693
	"	"	"	"	"	5	7.875	7.593	7.827	8.390	7.922
	"	"	"	"	"	7	8.303	8.764	8.390	8.452	8.477
	"	"	"	"	"	9	8.303	8.378	7.452	7.452	7.897
	"	"	"	"	"	11	7.822	8.063	7.593	7.688	7.793
Crushed Gravel, passed through 40-mesh sieve	"	"	"	"	"	13	7.125	7.125	8.063	8.126	7.610
	"	"	"	"	"	15	7.125	7.265	7.545	7.125	7.265
	"	"	"	"	"	5	9.525	9.075	11.550	11.212	10.341
	"	"	"	"	"	7	10.350	10.275	11.025	10.875	10.631
	"	"	"	"	"	9	10.950	11.175	11.438	9.975	10.884
Sand from Fontainebleau	"	"	"	"	"	11	10.425	11.175	12.000	10.050	10.912
	"	"	"	"	"	13	11.175	9.188	11.250	11.625	10.810
	"	"	"	"	"	15	10.050	9.825	10.050	10.725	10.163
	8	92	3.750	120	8	5	1.912	1.987	2.025	1.950	1.968
	"	"	"	"	"	7	2.175	2.362	2.400	2.475	2.343
Sand from Fontainebleau	d	"	"	"	"	9	All	test pieces disintegrated			
	e	"	"	"	"	13	"	"	"	"	
	12	88	"	"	"	5	2.062	2.250	2.100	2.062	2.118
	a	"	"	"	"	7	2.362	2.250	Disintegrated		2.304
	b	"	"	"	"	9	All	test pieces disintegrated			
Sand from Fontainebleau	c	"	"	"	"	13	"	"	"	"	

The second set of tests was exposed to the atmosphere of the laboratory room.

The third series was placed in a drying oven kept at a temperature of between forty and fifty centigrade.

Then each of the three series of tests was divided into three lots, the first of which was to be hardened after twenty-four hours, the second after forty-eight hours and the third after having been exposed for a week to the three different conditions of moisture described.

The results recorded in Table XXIII demonstrate that, in the case of pure lime, the strength is the highest if the moulded cylinders are not dried out at

In every instance, the pure lime has given superior results to hydraulic lime. These tests, furthermore, show that the common practice of loading a great number of cars with moulded sand-lime brick before closing the hardening cylinder does not cause the strength to decrease, as even exposure to the atmosphere for twenty-four hours did not affect the strength in the least.

The tests made at a temperature of from 40 to 50 centigrade teach the lesson that it is unwise to place moulded brick in hardening cylinders which are still hot, unless a cylinder is filled in a short time and the steam is turned on immediately afterwards. After

TABLE XXIV.

THE SAME SAND-LIME MIXTURE, SUBJECTED TO VARYING PRESSURE IN MOULDING AND TO VARYING STEAM PRESSURE. ALSO THE DURATION OF THE HARDENING PROCESS WAS VARIED.

No. of Test Piece	Initial Com- pression of Mixture lbs.	Steam Pressure lbs.	Time of Expos- ure to Steam. Hours	Resistance to Compression after hardening in lbs. per sq. in.				Average.
516	3.750	60	4	.525	.788	.675	.713	.690
517	7.500	"	"	1.050	1.050	1.050	.975	1.020
518	11.250	"	"	1.050	1.088	1.162	1.200	1.125
519	15.000	"	"	1.388	1.538	1.350	1.388	1.418
520	3.750	"	6	1.388	1.425	1.425	1.388	1.410
521	7.500	"	"	1.688	1.725	1.650	1.725	1.770
522	11.250	"	"	1.950	2.700	2.475	2.362	2.588
523	15.000	"	"	2.550	2.288	3.150	3.713	2.925
524	3.750	"	8	1.650	1.725	1.650	2.025	1.575
525	7.500	"	"	2.138	1.950	2.213	2.025	2.085
526	11.250	"	"	2.100	2.550	1.950	2.513	2.280
527	15.000	"	"	2.888	2.662	2.925	2.513	2.745
528	3.750	"	10	1.688	1.538	1.800	1.725	1.688
529	7.500	"	"	1.988	2.025	2.250	2.175	2.115
530	11.250	"	"	2.588	2.288	2.400	2.175	2.363
531	15.000	"	"	3.225	3.000	3.150	3.150	3.135
532	3.750	90	4	1.012	1.012	1.027	1.050	1.017
533	7.500	"	"	1.425	1.425	1.425	1.275	1.200
534	11.250	"	"	1.650	1.650	1.612	1.650	1.635
535	15.000	"	"	2.025	2.063	1.950	1.950	1.995
536	3.750	"	6	2.325	2.288	2.213	2.175	2.250
537	7.500	"	"	2.850	2.888	2.738	2.812	2.820
538	11.250	"	"	3.150	3.375	3.375	3.150	3.255
539	15.000	"	"	3.750	3.600	3.562	3.600	3.630
540	3.750	"	8	2.550	2.700	2.550	2.550	2.588
541	7.500	"	"	2.812	3.038	2.775	2.775	2.850
542	11.250	"	"	3.525	3.150	3.300	3.338	3.330
543	15.000	"	"	3.825	3.713	3.375	3.713	3.660
544	3.750	"	10	2.700	2.700	2.662	2.550	2.655
545	7.500	"	"	3.225	3.150	2.112	3.225	3.180
546	11.250	"	"	3.750	3.712	3.862	3.712	3.765
547	15.000	"	"	4.050	4.162	4.162	3.750	4.035
548	3.750	120	4	2.888	2.475	2.438	2.438	2.565
549	7.500	"	"	3.188	3.188	3.975	3.262	3.210
550	11.250	"	"	3.488	3.525	3.638	3.713	3.585
551	15.000	"	"	4.162	3.975	4.012	3.975	4.035
552	3.750	"	6	3.112	3.038	3.112	3.075	3.075
553	7.500	"	"	3.788	3.788	3.712	3.675	3.750
554	11.250	"	"	4.312	4.425	4.088	4.125	4.230
555	15.000	"	"	4.200	4.688	4.725	4.762	4.590
556	3.750	"	8	3.375	3.525	3.600	3.600	3.525
557	7.500	"	"	3.975	3.938	3.975	4.088	3.990
558	11.250	"	"	4.125	4.050	4.050	4.050	4.125
559	15.000	"	"	4.462	4.425	4.388	4.388	4.425
560	3.750	"	10	3.450	4.125	4.012	4.012	3.900
561	7.500	"	"	4.762	4.762	4.912	4.762	4.800
562	11.250	"	"	5.250	4.958	5.212	4.500	4.980
563	15.000	"	"	5.512	5.438	5.362	5.175	5.370

(Continuation of this table on opposite page.)

TABLE XXIV—Continued.

THE SAME SAND-LIME MIXTURE, SUBJECTED TO VARYING PRESSURE IN MOULDING AND TO VARYING STEAM PRESSURE. ALSO THE DURATION OF THE HARDENING PROCESS WAS VARIED.

No. of Test Piece.	Initial Compression of Mixture lbs.	Steam Pressure lbs.	Time of Exposure to Steam. hours	Resistance to Compression after hardening in lbs. per sq. in.				Average.
564	3.750	150	4	3.488	3.600	3.488	3.862	3.495
565	7.500	"	"	4.012	3.938	3.750	3.675	3.840
566	11.250	"	"	4.388	4.125	3.975	3.862	4.035
567	15.000	"	"	4.725	4.388	4.463	4.312	4.470
568	3.750	"	6		3.675	3.562	3.750	3.660
569	7.500	"	"	4.538	4.950	4.762	4.762	4.755
570	11.250	"	"	5.325	5.212	5.588	5.250	5.340
571	15.000	"	"	5.438	5.925	5.362	5.962	5.670
572	3.750	"	8	4.575	4.425	4.275	4.612	4.470
273	7.500	"	"	4.612	4.125	4.238	3.938	4.230
574	11.250	"	"	5.138	5.438	5.738	4.988	5.325
575	15.000	"	"	6.075	5.700	5.775	5.775	5.835
576	3.750	"	10	4.275	4.912	4.755	4.350	4.560
577	7.500	"	"	4.462	4.950	5.040	4.852	4.830
578	11.250	"	"	5.415	3.985	5.370	6.030	5.625
579	15.000	"	"	6.570	5.708	6.308	5.955	6.135

TABLE XXIII.

RESULTS OBTAINED WITH SAND-LIME MIXTURES, FRESH AND PARTLY DRIED OUT

Lime per cent	Sand per cent	Quality of Lime	Method of Preservation Before Hardening	Temperature Centigrade	Time of Preservation Before Hardening	Steam Pressure lbs.	Time of Exposure to Steam hours	Initial Compression of Mixture lbs.	Resistance to Compression after Hardening in lbs. per sq. in.				Average
10	90	Fat Lime	Glass jar	15	24 hours	120	6	3750	1.800	2.100	1.950	1.912	1.835
"	"	"	Laboratory	15	"	"	"	"	1.988	2.025	1.950	1.950	1.977
"	"	"	Drying oven	40-50	"	"	"	"	1.650	1.650	1.650	1.575	1.630
"	"	"	Glass jar	15	48 hours	"	"	"	1.425	1.425	1.725	1.875	1.590
"	"	"	Laboratory	15	"	"	"	"	1.612	1.538	1.688	1.800	1.658
"	"	"	Drying oven	40-50	"	"	"	"	1.500	1.575	1.575	1.538	1.565
"	"	"	Glass jar	15	1 week	"	"	"	1.575	1.470	1.530	—	1.525
"	"	"	Laboratory	15	"	"	"	"	1.312	1.350	1.425	1.238	1.368
"	"	"	Drying oven	40-50	"	"	"	"	1.425	1.350	1.275	1.350	1.350
"	"	Hydraulic Lime	Glass jar	15	24 hours	"	"	"	1.125	1.050	1.125	1.125	1.105
"	"	"	Laboratory	15	"	"	"	"	1.125	1.050	1.050	1.050	1.068
"	"	"	Drying oven	40-50	"	"	"	"	975	862	900	900	910
"	"	"	Glass jar	15	48 hours	"	"	"	1.125	1.050	1.088	1.050	1.077
"	"	"	Laboratory	15	"	"	"	"	1.200	1.162	1.125	1.125	1.156
"	"	"	Drying oven	40-50	"	"	"	"	1.088	900	975	—	987
"	"	"	Glass jar	15	1 week	"	"	"	525	487	638	638	572
"	"	"	Laboratory	15	"	"	"	"	525	562	488	488	515
"	"	"	Drying oven	40-50	"	"	"	"	675	713	713	750	713

having been kept at 40-50 centigrade for twenty-four hours, the strength was only 1,630 lbs., as against 1,835 lbs. in the case of the specimens kept at 15 centigrade. However, the decrease in strength is not the only disadvantage accompanying this faulty method of working. The drying out of the corners and edges of the brick, especially of those on the outside of a carload, is to be feared even more. The cars with moulded brick are frequently put in cylinders warmer than 50 centigrade, and, as a result, corners and edges of the brick become so friable that they wear off very readily.

Therefore, it is necessary, if the heat of a hot hardening cylinder shall be utilized, to put all cars in at

XXIV) was made with a view to determining accurately the effect of this initial compression upon the final strength of the brick, which was to settle the question, whether or not there was a remarkable difference between the use of feeble presses and those of more powerful design.

Our experiments, therefore, were made with varying pressure, that is to say, the various sand-lime mixtures were moulded under a pressure of 3,750 lbs., 7,500 lbs., 11,250 lbs. and 15,000 lbs. per sq. in.

It is obvious that the particles of a slightly moistened sand-lime mixture will react upon each other the more perfectly and yield a product of greater density



RESIDENCE, MT. AIRY, PHILADELPHIA, PA.
Fire-place Built of Rock-faced Grey Sand-Lime Brick, Manufactured from Gneiss-Stone Dust at Factory of International Sand-Lime Brick & Machinery Co., in Washington, D. C.

a time, to close it right away and to turn on the steam.

The effects of drying out become even more noticeable, if the brick are made with hydraulic lime, as the second part of table XXIII shows.

Tests Made With Varying Initial Pressure: In the manufacture of sand-lime brick, the well prepared mixture of sand and hydrated lime is moulded in brick presses, of which there are a great number of different types on the market.

The following extensive series of tests (see table

the more completely they are compressed. We have demonstrated in the beginning (see tables II, III, IV and V) that the percentage of soluble silica, or in other words the amount of calcium silicate formed, increased with the pressure to which the sand-lime mixture was subjected and are now in a position to show that also the ultimate strength of the finished product increases in the same ratio.

Hence, if the ultimate strength of the brick is a given factor, a powerful press enables the manufac-

TABLE XXV

COMPARISON BETWEEN INITIAL COMPRESSION OF SAND-LIME MIXTURE AND ULTIMATE STRENGTH OF HARDENED PRODUCT

Initial Compression of Sand-Lime Mixture in lbs. per sq. in.			
3.750	7.500	11.250	15.000
Resistance to Compression after Hardening in lbs. per sq. in.			
6.90	1.020	1.125	1.418
1.410	1.770	2.588	2.925
1.575	2.085	2.280	2.745
1.688	2.115	2.363	3.135
1.017	1.200	1.635	1.995
2.250	2.820	3.255	3.630
2.588	2.850	3.320	3.660
2.655	3.180	3.765	4.035
2.565	3.210	3.585	4.035
3.075	3.750	4.230	4.590
3.525	3.990	4.125	4.425
3.900	4.800	4.980	5.370
3.495	3.840	4.035	4.470
3.660	4.755	5.340	5.670
4.470	4.230	5.325	5.835
4.560	4.830	5.625	6.135
2.695	3.150	3.600	4.005

turer to either decrease the steam pressure during hardening or to shorten the time of hardening, or even to decrease the amount of hydrated lime in the sand-lime mixture.

Table XXV contains all results of table XXIV grouped according to the initial compression of the sand-lime mixtures. The average of these figures is the following:

2695 lbs. for an initial compression of 3750 lbs.

3150 " " " " " " 7500 "

3600 " " " " " " 11250 "

4005 " " " " " " 15000 "

that is to say, the strength of the finished product, in the case of the highest pressure, is about 50 per cent higher than that due to the lowest compression employed.

In table XXVI, a short series of tests is recorded in which the same sand-lime mixture was compressed at a lower pressure, namely 750 lbs., 1,500 lbs., 2,250 lbs. and 3,000 lbs. These test pieces were hardened for eight hours at a steam pressure of 120 lbs.

Also in this case, the ultimate strength of the hardened product grew with the increased pressure put upon the raw mixture.

The outcome of this extensive series of tests, which necessitated the manufacture of not less than 256 test cylinders, is the advisability to make use of the most

powerful press that can be obtained. The first cost of the press, and the wear and tear, will be greater than that of an inferior press, but the manufactured product will have a higher compression strength, and last, not least, will be more resisting to frost, owing to its great density, which is one of the most important factors.

Steam Pressure: As the steam pressure is the cause of the chemical action of the hydrated lime upon the sand, it is easy to foresee the effect of increased pressure during the hardening, namely a rise of the compression strength in proportion to the steam pressure employed, as table XXIV shows in every instance.

Table XXVII contains all the figures of table XXIV recorded in accordance with the steam pressure to which the sand-lime mixture was subjected.

The average figures are:

1928 lbs. for steam pressure of 60 lbs.

2740 " " " " " 90 "

4008 " " " " " 120 "

4767 " " " " " 150 "

These results show plainly the important part which the steam pressure takes in the manufacture of sand-lime products.

Duration of Steam Pressure: Table XXIV shows furthermore, that, for equal steam pressure, the ultimate strength is the higher the longer the sand-lime mixture is exposed to the steam.

TABLE XXVII.

RELATION BETWEEN STEAM PRESSURE AND ULTIMATE STRENGTH.

Steam Pressure in lbs. per sq. in.			
60	90	120	150
Resistance to Compression after hardening in lbs. per sq. in.			
.690	1.017	2.565	3.495
1.020	1.200	3.210	3.840
1.125	1.635	3.585	4.035
1.418	1.995	4.035	4.470
1.410	2.250	3.075	3.660
1.770	2.820	3.750	4.755
2.588	3.255	4.230	5.340
2.925	3.630	4.590	5.670
1.575	2.588	3.525	4.470
2.085	2.850	3.990	4.230
2.280	3.330	4.125	5.325
2.745	3.660	4.425	5.835
1.688	2.655	3.900	4.560
2.115	3.180	4.800	4.830
2.363	3.765	4.980	5.625
3.135	4.035	5.370	6.135
1.928	2.740	4.008	4.767

TABLE XXVI.

Initial Compression of Mixture lbs.	Steam Pressure lbs.	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs. per sq. in.				Average.
.750	120	8	1.875	1.612	1.927	1.448	1.716
1.500	"	"	1.927	1.700	2.272	2.062	1.990
2.250	"	"	2.520	2.205	2.242	2.348	2.328
3.000	"	"	2.535	2.385	2.685	—	2.585

TABLE XXVIII.

EFFECT OF TIME OF EXPOSURE TO STEAM UPON FINAL STRENGTH OF PRODUCT.

Time of Exposure to Steam in hours.			
4	6	8	10
.690	1.410	1.575	1.688
1.020	1.770	2.085	2.115
1.125	2.588	2.280	2.363
1.418	2.925	2.745	3.135
1.017	2.250	2.588	2.655
1.200	2.820	2.850	3.180
1.635	3.255	3.330	3.765
1.995	3.630	3.660	4.035
2.565	3.075	3.525	3.900
3.210	3.750	3.990	4.800
3.585	4.230	4.125	4.980
4.035	4.590	4.425	5.370
3.495	3.660	4.470	4.560
3.840	4.755	4.230	4.830
4.035	5.340	5.325	5.625
4.470	5.670	5.835	6.135
2.460	3.477	3.563	3.945

Table XXVIII illustrates more fully the relation between the duration of the steam pressure and the final strength. This table contains all the figures of table XXIV grouped according to the time during which the sand-lime mixtures were exposed to steam.

The average strength was:
2460 lbs. for all test pieces subjected to steam 4 hours.
3477 " " " " " " " " 6 "
3563 " " " " " " " " 8 "
3945 " " " " " " " " 10 "

It would certainly be interesting to determine which would be the most economical in the manufacture on a large scale, to harden the sand-lime mixture for a short time at high pressure, to harden it for a long time at low pressure, or to subject the mixture to the highest possible pressure. This problem is not a simple one, as the obtaining of accurate data would involve a calculation including the cost of the machinery and its depreciation.

(To be continued.)

CENTRAL EQUIPMENT CO.

The Central Equipment Co., Ford Building, Detroit, Mich., makes a specialty of machinery used around cement plants, lime works and crushing plants that is to say of machinery employed for transporting, crushing, pulverizing, drying and burning of materials.

Their monthly stock sheet contains many attractive propositions of fully guaranteed equipment.

The men connected with the Central Equipment Co. are old in the cement business and therefore especially fitted to handle this class of machinery.

THE BOLTE MFG. CO.

The Bolte Mfg. Co. of Kearney, Neb., describes in its 1911 catalogue the up-to-date methods of handling concrete and shows in numerous illustrations the Bolte Concrete Mixer in use.

APPEAL IN PATENT CONTROVERSIES.

The bill to create a new court of patent appeals has been favorably reported to the senate by the committee which has had it in charge. The need of such a court has been obvious for years to students of the conditions relating to patent law and its administration by existing courts. As pointed out in the report, the judiciary act of 1793, when adopted provided for a single court of appeals in all cases. The Supreme Court of the United States was the single and only court of last resort recognized by that act. Nearly a hundred years passed before the law was changed, for it was entirely satisfactory to litigants, lawyers and the public, so long as the Supreme Court was able to take care of the business brought to its docket. No class of litigation suffered and cases in general were given satisfactory treatment. But as the volume of business increased, and the number of cases became so great that it seemed that years might elapse before some of them were reached, the necessity for some means of lessening the pressure upon the court, and of affording litigants prompt relief, became obvious. It was impossible for the judges of the Supreme Court to consider adequately and satisfactorily, either to themselves or to the public, the increasing number of cases brought to it on appeal. In 1891, therefore, the circuit courts of appeal were created by an amendment to the judiciary act, and the results have been what was hoped for in all cases except those relating to patents. In the latter class of cases, the rights of the public and of patentees are still in confusion and uncertainty.

The nine circuit courts of appeal have exercised their jurisdiction as courts of last resort in litigation over general matters without such confusion and uncertainty. This is due to the fact that, as a general proposition, a decision in litigation of this sort has been final and binding with respect to the parties to the suit and to the subject-matter involved. In patent cases the reverse has been true, because a patent right is co-extensive with the United States, and yet it is the subject of determination of nine different courts of last resort, no one of which is bound by the other. The result is a conflict of judgments and a confusion of titles. The reports of the circuit courts of appeals abound with instances of this confusion in respect to patent titles. Under the present system, a patent may be decreed to be valid by the circuit courts of appeal in eight circuits. If, in the ninth circuit, the court decrees the patent to be invalid, the patentee has lost part of the benefits of the decision in the other eight circuits, because in the ninth circuit anybody may manufacture the article and it may be sold throughout the United States. Such a condition is of course destructive of the rights of the patentee and is also an injury to the public.

As Senator Brown, chairman of the Senate Committee on Patents, said in submitting the committee report to the senate, any system which resulted in litigation of that kind, of which there were many instances, called for readjustment. The only adequate remedy is the creation of a single court of appeals, which should have exclusive appellate jurisdiction in patent cases. It would hear and determine appeals and writs of error from final judgments and decrees in circuit courts of the United States, in cases arising under the laws relating to patents for inventions. Its decisions would be final within its jurisdiction, though, of course, the Supreme Court might review them in certain cases.

The public is entitled to know whether it has a right to make, use or trade in any article of commerce at the end of a decision of one court of last resort, and ought not be compelled to wait on the harmonious judgment of nine courts of last resort. On the other hand, the rights of the patentee can be clearly established only through the decision of a single court of this kind. The proposed legislation is chiefly in the interest of the inventors of the country. The patent system of this land should be strengthened so that the man who invests something will be given a change during his life, and will be on even terms before the courts with those great corporations which are interested in the control of patents covering an entire field of industry. The expense of the court would not be great, as the associate justices would be drawn from the different circuits for service at an annual session. We earnestly hope that the bill will receive favorable attention, and be enacted into law.

BIG INCREASE IN PRODUCTION OF PORTLAND CEMENT IN 1910.

The statistics of cement production in 1910, as reported by Ernest F. Burchard, of the United States Geological Survey, indicate that the cement industry ranks within the first eight extractive industries in the United States, the value of the cement manufactured being exceeded only by the value of the coal, pig iron, petroleum and gas, clay products, copper, gold, and stone produced.

The total quantity of Portland, natural and puzzolan cements produced in 1910 was 76,934,675 barrels, valued at \$68,052,771. This was an increase of 10,244,960 barrels, or 15.3 per cent in quantity, and of \$14,442,208, or 26.9 per cent in value, over the figures of 1909. The increase in quantity is one of the largest ever recorded, and the fact that the increase in value was proportionately higher indicates that trade conditions were slightly more satisfactory than during 1909.



Reinforced Concrete Arch Bridge, Silver Springs, Md.

REINFORCED CONCRETE ARCH BRIDGE.

The country bridge has wonderful possibilities. A few years ago there was no effort at more than bridging a stream. Beauty was a consideration subordinated to cost and efficiency, but with the introduction of concrete has come a change in ideals for country bridge construction. We no longer have the unsightly superstructure that must accompany the best of steel designs. We have no longer the marring of beautiful surroundings by the use of materials which cannot be made a part of the natural scenery. The bridge illustrated below is an especially good example of a design that is in perfect harmony with its surroundings and one which is a permanent investment. There will be no painting or renewing of floors.

This bridge spans a creek near Silver Springs, Md., and was built in connection with the road improvement work under the Maryland Road Commission of which W. W. Crosby was the chief engineer. Daniel B. Luten of Indianapolis, designed the structure and M. D. Knight, Road Superintendent of Montgomery County, superintended the construction. The bridge has a span of 55 feet, a width of roadway of 22 feet and has a clear height of 20 feet above normal water level.

Portland cement constituted the main item in this output, the total for the year being 75,699,485 barrels, valued at \$67,506,479. The average price per barrel in 1910, according to the figures reported to the Survey was a trifle less than 89.2 cents. This represents the value of the cement in bulk at the mills, including the labor cost of packing, but not the value of the sacks or barrels. The prices ranged generally between 72.7 cents a barrel in the Lehigh district and \$1.38 on the Pacific coast. While the average price for the whole country increased from 81.3 cents in 1909 to nearly 89.2 cents in 1910, with corresponding increases in the eastern, central, southern and western districts, the average price in the Pacific coast states dropped from \$1.52 to \$1.38, a decrease of 14 cents a barrel, due, no doubt to the advent of new mills in California, the Rocky Mountain states, and western Texas, and to the increased capacity of other plants supplying the coast territory, where attractive prices have hitherto prevailed.

The number of producing plants increased from 108 in 1909 to 110 in 1910, but the total number of rotary kilns in operation decreased from 930 to 900. The figures indicate, however, that the proportion of large kilns is increasing, 471 kilns 100 feet or more in length being reported in 1910.

Some Problems of the Cement Industry

By Walter S. Landis

If one were to ask the average mechanical engineer for information concerning the cement industry he would most likely be told that this industry belongs to the field of the chemist. This idea is quite as erroneous, as it is prevalent among mechanical engineers. It may be true that in the early days of the industry the chemist occupied the most important position, but today the mechanical engineer is at the head of our great plants and the chemist has degenerated into a very subordinate official. There are reasons for this change, the most important one being that it is easier for the mechanical engineer to pick up the necessary chemical knowledge than it is for the chemist to acquire the requisite mechanical training. Again, the rigid requirements as laid down by the early chemists for the manufacture of a passable product are no longer recognized as true since we have learned so much more about the technology of cement. As a result we have been having the development of the plant as against the process, and the mechanical engineer, of course, plays the most important part in such plant development.

What we today understand as Portland cement is a certain compound of silica, alumina and lime in the proportions of SiO_2 , 10 to 23 per cent; Al_2O_3 , 8 to 10 per cent; and CaO , 62 to 65 per cent. It is not possible to obtain these ingredients in large quantities in a state of absolute purity and we frequently find alumina replaced by ferric oxide, up to 3 per cent, and lime by magnesia, up to 2 or 3 per cent, so that actual cements as found on the market diverge slightly from the above analyses without, however, suffering greatly in their physical properties. It must also be remembered that the well-known Portland cement is **only one of a dozen** chemical compounds which harden or set when mixed with water and that it has attained its great importance because of the ease and cheapness with which it can be manufactured and not because of any peculiar properties not possessed by certain other compounds.

Simply the mechanical mixing of silica, alumina and lime in the above proportions will not yield a compound possessing the properties of Portland cement. It is essential that these ingredients be in a manner combined, not exactly as a true chemical compound, but rather as a physico-chemical solution of one or more chemical compounds in each other. The mixture must be finely ground before it will exhibit the characteristic setting property. The best and practically the only way in which such a union can be attained is by a complete or partial fusion of the silica, alumina and lime mixture. Such a partial fusing is called sintering or clinkering.

All the laws of physical chemistry relating to the formation of slags and fused mixtures apply also to the formation of the clinker, a few of the more important facts being here mentioned. The melting point and the clinkering temperature are dependent on the purity of the mass clinkered, being lowered by the presence of such impurities as oxide of iron, magnesia, alkalis, etc. It is a well-recognized fact that the so-called white or stainless cements require a much higher temperature for clinkering than the dark colored and more impure mixtures. The temperature required for clinker formation depends on the intimacy of the contact of the various clinkering ingredients, the finer the individual materials are ground the lower the temperature required.

Since we know that such a thing does not exist as an overburned cement, a fusion of the properly proportioned ingredients would solve the question of a homogeneous product. But such a fusion has not proved advisable in practice and the cement manufacturer has had to content himself with a sintered or clinkered product, that is, one which has been raised in temperature to a sticky or viscous stage and not actually liquified. As such clinkered product is at no time a mobile liquid we cannot depend on liquid diffusion for the proper mixing of the silica, alumina and lime but must do such mixing purposely. To ensure the necessary contact between these ingredients so that they can unite chemically to a homogeneous whole when in the state of only incipient fusion, they must be most finely ground and most thoroughly mixed. Therefore the first stage in all cement processes, as at present practiced, is a preliminary grinding and mixing of the raw materials.

The first consideration in the grinding of a material is a study of the properties of the material to be ground. This in turn leads us to a description of the raw materials entering into the manufacture of Portland cement. Of first importance among these is cement rock, an argillaceous limestone, lying both in composition and in geological position between the true limestones and the slates. It is a natural mixture of carbonate of lime and clay, which on heating to the clinkering temperature loses its combined water and carbonic acid and unites together into a fritted mass of the desired composition and properties. It is shaly in nature, not very hard, and of varying degrees of toughness. In several favored parts of the country, as for instance one or two places in the Lehigh Valley region, this rock needs no further treatment other than quarrying, comparatively coarse crushing and burning to form a first-class clinker. Usually the ingredients are not present in the natural rock in exactly the desired proportions and the one lacking, generally lime, must be added. Sometimes in this region there will be two strata or benches in the same quarry so constituted that by mixing rock from the two in certain proportions, the silica, alumina and lime will be in the desired proportions in the clinkered product.

Where materials are found to be so near the desired composition as to require practically no mixing, the grinding is a simple proposition. Only such fineness would be required, if the rock were of uniform composition, as would insure the kiln producing a properly burned product when run at a predetermined capacity. This would really be a sizing rather than a grinding. On the other hand, if the rock is non-homogeneous or requires some mixing to make a properly constituted clinker, then finer and finer and finer grinding, proportionate to the degree of non-homogeneity or amount of mixing required, must be done to enable the mixture to attain the composition desired in the clinker. No hard and fast rule can be laid down for the required fineness of grinding. It must be suited to the individual case, remembering that sometimes the financial success of the plant depends on making a passable product with the coarsest allowable grinding. The kiln temperature, as well as the length of time the mass is subjected to this temperature, influences the required fineness of grinding. The finer the grinding the easier the clinkering and, therefore, the capacity and coal consumption of the kilns are directly proportional to the fineness of

the ground mix fed in. It has been found in practice within the past few years to be more economical to grind very fine before burning, even though such a degree of fineness of the raw material would not actually be required to make a satisfactory clinker. In other words, the coal used to drive the grinding machines to produce this extra fineness is less than that saved in the kiln, and at the same time the capacity of the kiln is greatly increased. It has also been said, though I cannot verify it from actual observation, that the finer the grinding of the raw material the easier the clinker is to grind afterwards. This might be explained by the fact that the lower temperature at which the finer mix clinkers leads to the formation of a softer clinker. In that case the power put into the preliminary grinding would at least be partially saved in the finishing department. A more thorough study of this question is one of our problems.

But it must not be understood that the manufacture of cement is confined to those favored localities in which cement rock is found. A mixture of clay and limestone can be prepared artificially of such composition that when the combined water in the clay and the carbonic acid of the limestone are driven off by heating, the residue will form clinker of the desired composition. Here we have materials of entirely different composition and nature to be mixed, and the grinding of each must be exceptionally fine in order that they may combine under economical conditions of kiln running. It is recognized by cement men that the manufacture of a satisfactory cement from limestone and clay entails a different mill equipment from that in use in the Lehigh Valley region, where the raw material is a nearly perfect cement rock. Such raw materials, to be properly mixed, must be ground so that practically all will pass a 100 mesh screen and nearly all a 200 mesh.

Other raw materials available are marl mixed with limestone or clay, shale mixed with limestone, and even blast-furnace slag mixed with limestone. This latter material is at present receiving a great deal of attention from cement men. The iron blast-furnace slag is composed of silica, lime and alumina, and by the addition of limestone, clinker of the desired composition can be produced. It has the advantage of being a waste product which the furnaces are glad to get rid of and at the same time needs no quarrying or coarse grinding, since it is granulated in water when tapped from the blast furnace. All materials like clay and limestone require exceedingly fine grinding (all through 100 mesh, 50-70 per cent through 200 mesh) in order to insure proper combination in the kiln.

It is not possible to discuss in detail the many problems connected with fine grinding of the large quantities of rock and clay which the cement industry handles. In quarrying the rock the percussion drill, such as is used in the digging of ordinary drilled wells, is largely used for making the blasting holes, a series of holes being drilled along the face of the quarry 15 to 20 ft. back. The author has seen single blasts bring down from 20,000 to 40,000 tons of rock. After blasting, the rock is loaded up into dump cars in many quarries by the use of a steam shovel. These cars are moved to the foot of the hoisting incline by gravity or mule power, and are pulled up by a donkey engine. Considerable engineering skill must be brought to bear on the economical handling of the quarried rock in the quarry itself. After arriving at the top of the quarry the car is run into the crushing house, where the stone is weighed and dumped into the first crushing unit.

American and European practices differ in the size of this first crusher, which is almost universally of the

gyratory type. With us, hand labor is expensive and must be dispensed with wherever possible. We therefore build this unit as large as is required to take any single piece of rock which the steam shovel can load into the dump car. When such a carload is dumped into the crusher the driving motor of the crusher suffers a momentary peak-load as the rock goes through, which load then drops off to nothing until the next car arrives. These crushers sometimes take a piece of rock 30 to 36 in. in diameter, using at the peak 250 h.p. In Europe, the rock as quarried is broken much smaller, usually by hand sledging, thereby permitting the use of a number of smaller gyratories, and so distributing the load on the motor more uniformly throughout the day. In our country the first large coarse crushers are followed by smaller ones of the same type, and in the newer mills these are driven from the same power source as the larger ones.

The advisability of using the very largest types of crushers made is a much discussed point among cement men. When one considers that the very large pieces of rock quarried are the exception rather than the rule and that the crusher is rarely called upon to take one the size of its opening, it seems questionable to fit a mill with such a machine. A stick of dynamite laid on such a large piece will easily reduce it to a size readily handled by the smaller crushers (even in this case larger than the European crushers), and so eliminate the enormous peak loads and expensive machinery. Several large new mills have not provided themselves with the largest procurable type of crushers made, even though their output would warrant it. This question of crusher size is another of the problems of cement manufacture awaiting final solution.

The drying of the product of the gyratories is the next stage in cement manufacture. The fineness to which the material is to be ultimately ground makes it necessary to remove all hygroscopic moisture, otherwise clogging of screens and cutting down of capacity of the fine grinding mills would result. The driers are cylindrical steel shells capable of being rotated on their axes and are set slightly inclined in order to insure progressive motion of the charge through them. The wet, coarsely crushed material is fed in at the upper end and hot gaseous products from a coal fire or natural gas flame pass in at the lower end and over the charge to be dried. They are frequently provided with buckets, formed of Z-bars riveted to their inner surface, to pick up the rock and carry it part way around and so drop it through the gases passing through the drier and at the same time advance it through the kiln. At times they are divided into compartments to insure closer contact between the heating gases and the rock, but this design is gradually dropping out of use. The great decrease in capacity of a compartment drier over the ordinary type more than offsets the greater heat transfer from the gases to the feed. It is only recently that attempts have been made to utilize the hot gases from the kilns to perform the drying of the mix. Several such installations have recently been made and are working with great success.

The drying of clay for fine grinding presents an unusual problem, because after being dried it must be used immediately, as it again takes up moisture from the atmosphere. This usually results in a double drying operation: first just before disintegration, after which it goes into storage, and a second drying after lying in storage and just before final grinding.

From the driers the rock passes to one of the various types of fine grinding mills, such as the ball and tube mills, or mechanical mills like the Griffin and Fuller.

The excellent catalogues furnished by the manufacturers of this class of machinery make it unnecessary to describe them in detail here and reference is made to them in full confidence in the reliability of the data there found. The product leaves these mills so finely ground that more than half of it will usually pass a screen of 200 meshes to the linear inch. It has been universal practice to fit the mechanical mills with screens (no screens in the tube mills) of 30 to 40 mesh openings, through which the product of the mill has to pass before discharge. Such screens are placed so that the material discharged from the mill strikes them at an acute angle and the full size of the opening is never available to the discharged product. Recently air separators have been tried as a substitute for the expensive and troublesome screens.

So far nothing has been said of the mixing of the raw materials to insure proper composition of the finished cement. This mixing practice has varied greatly. Originally the several ingredients were ground separately, mixed with water until thin enough to flow readily, and streams of each run upon a drying floor. Their fluidity insured mixing. After drying for some time, the mass was rolled into balls or pressed into bricks, and stored until ready for charging into the clinkering furnaces. To-day this practice is obsolete and in its place we have the two great systems under which modern mills operate. They are known as the wet and the dry processes, their chief differences being based on the operation of mixing. In the wet process the two ingredients are ground separately, mixed with water until thin enough to flow, pumping assisting in this conveying if necessary, and are charged in approximately the desired proportions into large agitating tanks for mixing. The final adjustment of the composition is made in these tanks. The wet mixture is then pumped from these tanks directly to the kilns.

In the dry system the properly weighed and proportioned materials are first separately crushed in the coarse crushers, and are fed together into the fine grinding mills, practice varying somewhat as to the exact mill into which the two materials first come into contact. The operation of grinding performs all the mixing required. For the same material it is supposed that finer preliminary grinding is more necessary in the dry process than in the wet for the same quality of cement. It seems to the author useless to add 50 to 100 per cent of water to a mass of ground material and then to evaporate that water again, when the dry process is working so satisfactorily.

Considerable changes have been made in the arrangement of the preliminary or raw grinding side of the mills as the industry developed. It is expensive to handle material and to transmit power. In the older days of the central power plant and lineshaft drive, the mills were arranged solely with a view to economy of power transmission and much handling of the material between the various crushing and grinding units was the result. To-day the individual motor drive is supreme, with the result that I have seen modern mills so laid out that there is scarcely any handling of material in the whole grinding department, the first elevation occurring into bins above the kilns. Gravity was used to feed from one unit to the next. Such an arrangement is not always the most advantageous when it comes to a breakdown; and the mill must be built on a hill-side, which means awkwardness in handling repair parts. The ideal mill would probably require at least three elevators in this department, and since the power required by such elevators would be hardly

over two or three per cent of the total power installation of the plant, it is really not a serious item.

Another feature of mill design receiving attention is storage capacity. The rough handling of the machines causes them, rugged as they are, to be laid off for repairs. It is necessary, to insure running of the mill to provide ample storage capacity between the various classes of grinding machinery so that a stoppage of one part will not cause the shutdown of the entire mill. Several very recent mills have provided storage capacity as follows: a 4-day supply of gyratory discharge, a 12-hour supply of ball mill feed, a 12-hour supply of finishing mill feed and a 24-hour supply of kiln feed. It must be remembered that climatic conditions have a marked influence on the consideration of storage capacity.

The kilns originally used for burning the mix to clinker were fixed, vertical, bottle-shaped furnaces. The balls or bricks made by the old wet process previously described were fed in at the top and the burned product drawn out at the bottom. The product was so irregularly burned that hand sorting had to be portion containing uncombined lime and not being suitable for the manufacture of a sound cement. While the fuel consumption of such a kiln is much below that of the usual rotary kiln, the labor and attendance charges are very high and the apparatus has been obsolete in this country for many years. Even Germany, a country of cheap labor, is now replacing this type of kiln by our own rotary design.

The modern rotary kiln consists of a cylindrical steel shell lined with refractory material and supported on rollers in cradles, its axis being slightly inclined from the horizontal. A rotation on its bearings is secured through one of the many types of variable-speed transmission. Its upper end enters into what is called the chimney hood, a dust trap and chimney support combined, and its lower end into another movable hood adapted for the discharge of clinker and the entry of fuel nozzles for pulverized coal, gas or oil. Pulverized coal is the most widely used fuel in cement burning. In size these kilns vary from 60 ft. long and 5 ft. in diameter up to 240 ft. long and 12 ft. in diameter. The output of a kiln is not easily determined, as it varies much with the nature of the product to be clinkered, the degree of fineness of the feed, the moisture to be evaporated, and whether the driving demands is for efficiency of operation or for capacity. Great capacity is not synonymous with high efficiency in a cement kiln. For example, a 60-ft. kiln in the Lehigh region will have a capacity of 200 bbl. of clinker per day and the 240-ft. kiln of approximately 2,500 bbl. per day. The lining of the kiln, at least at the hot end, is either of bauxite or magnesite brick in the majority of installations, though a highly refractory fire-clay may be used. Either of the first two linings are of a much higher heat conductivity than the latter.

One of the features of kiln design needing the attention of the fuel engineer is the stack. One sees on the same sized kilns stacks of all heights and diameters and not all can be highly efficient and economical. Some steps should be taken to investigate this question and to formulate a standard design embodying economy and efficiency.

Some of the finely ground material fed into the kiln is picked up by the gases passing through the kiln and passes into the chimney. Provision must be made in its design for settling out as much as possible of this dust, and too often one sees a narrow chimney on a kiln carrying out clouds of finely ground material and scattering it for miles over the surrounding country.

This material consists of the extreme fines so to be greatly desired in the product.

The physical and chemical reactions taking place in the raw material as it passes through the kiln, starting with its charging at the higher or chimney end of the kiln are as follows: rise in temperature accompanied by evaporation of water, if present, such evaporation holding the temperature constant at about 100 deg. cent. in the wet processes; rise in temperature up to about 300 deg. cent. where chemically combined water such as occurs in clay is driven off, the rise being less rapid during such dissociation; rise in temperature up to about 800 deg. cent., where the carbonic acid of the limestone is driven off, the rise in temperature being again sharply checked by the heat absorption occasioned by this decomposition; a rise in temperature up to that of clinkering, 1,200 to 1,400 deg. cent., depending on the various conditions existing in the chemical composition and physical properties of the mix as already discussed; rapid rise in temperature to a maximum, at times higher than the temperature of the flame in the kiln, due to the heat of combination of the ingredients in forming the clinker; rapid drop in temperature as the material is discharged from the kiln. It is not possible to define in feet and inches the length of each zone because of the variable character of the raw material in each cement producing district and of the great differences of kiln length. A specific case was discussed in the paper, read before the **Society of Mechanical Engineers** by Mr. Soper in November, 1910.

If we consider for the time being the charge of a kiln in the Lehigh Valley region where cement rock and the dry process are used, the net heat required by the above chemical reactions would be furnished by the combustion of about 16 lb. of average long-flame bituminous coal per barrel of clinker formed. This amount would be increased where clay and the wet process are used because of the heat absorbed in evaporating water and decomposing the hydrated compounds. The average fuel consumption of coal-fired cement kilns throughout the country is about 90 lb. of coal per bbl. of clinker, the calorific value of the difference between this figure and the one just given being lost as sensible heat in the discharged clinker and chimney gases and by radiation and conduction from the kiln shell. Waste of fuel of this magnitude should certainly appeal to the fuel engineer as well worthy of attention, particularly if he considers the magnitude of the industry. In 1910 this country made nearly 70,000,000 bbl. of cement. It is only recently that intelligent attempts have been made to reduce the heat losses of the kiln, or to utilize the waste heat in other operations. A feeble attempt has been made in this country to pass the hot chimney gases (temperatures averaging 500 deg. cent.) through the driers and so eliminate the extra fuel required in that part of the plant. Such installations are very successful. The regeneration of the heat in the discharged clinker by passing it through an under-cooler and preheating the incoming air has not proved satisfactory in many installations because of the stupidity of the operators. Where properly run, this system is saving hundreds of tons of coal per year. The main trouble has been that the kilns became too hot and the clinker stuck to the sides, all because the kiln manager did not deem it necessary to cut down the fuel when heat units were fed in another manner. German cement manufacturers used both the dryer and the under-cooler with their kilns almost from the introduction of the rotary type. It is only since the publication by the author of figures on radiation from kilns and the means of reducing such losses, that attempts have been made to save fuel by the installa-

tion as a backing to the usual kiln lining of a new heat insulating material.

It is not impossible to conceive of the use of a different and more efficient type of furnace than the rotary kiln for performing the clinkering operation. Surely fuel engineers have a prize well worth striving for when one considers that a saving of 10 to 15 lb. of coal per bbl. of clinker means a saving of three-quarter of a million dollars annually to the cement industry.

The clinker, after leaving the kiln, is passed through a series of cooling devices to dissipate quickly the heat it contains, and is then stored in heaps in the weather to age. Cement that has been underburned or improperly mixed so that it contains free lime will not pass the boiling test. If allowed to remain in the weather for some time so as to slake this lime and even lose some of it by solution, the cement prepared from such weathered product is generally of improved quality. The aging of clinker renders it softer and more easily ground, increasing the output of the grinding mills as much as 50 per cent. The elevators and overhead devices needed to handle such a storage are not expensive or complicated. The increased capacity of the grinding machines more than off-sets the power required by the conveying and storage machinery, and it is believed that the consequent ability to grind finer also offsets the bad effects of any uncombined lime which may be present.

After being recovered from the aging heaps the clinker passes into the final grinding department of the mill. This is similar to the raw grinding department with the omission of the gyratories and dryers. Gypsum is mixed with the clinker and the mass then passes to the grinding mills to be again reduced in size. As we have seen that clinker may lie exposed to the weather without taking up water, there must be a maximum size of particle which will combine it with water. This has been variously placed at about 150 mesh size, all particles coarser than that being inert in the finished cement. For this reason it is necessary to grind so that the greater proportion of the product will again pass through the 200 mesh screen. After this grinding the cement passes to the stock house, where it is stored for packing and shipment. It is now packed by automatic weighing and packing machines, in barrels and bags, the latter predominating.

It is not possible here to take up the important subject of conveying machinery as applied to the cement mill. Practice has greatly standardized itself in this respect into the use of buckets for elevating, air not proving successful. Lump material like clinker is carried on belts or by drags, and the screw conveyor has no great competitor in the conveying of fine material.

The power required for driving the mill varies very much with the type of installation. With the old shaft drive it was not infrequent to use $1\frac{3}{4}$ h. p. per bbl. of output per day. Some of the new motor-driven plants use as low as 2-3 h. p. per bbl. per day, and the average throughout the country is not far from $1\frac{1}{4}$ h. p. With the decreasing profit in cement manufacture the difference between the minimum and the average power requirements as given above should be sufficient to cause a remodelling of power plants and transmission machinery in the older mills. The gas engine should find a growing field in this industry because the individual machines lend themselves so readily to motor driving. The labor requirement of the various mills seems to run parallel with the power requirement. In the older mills 8 bbl. of cement per day per man

employed was a good average, while the newer mills are producing 16 bbl.

Cost figures are difficult to obtain in any privately controlled and competitive industry, and the cement industry is no exception. In a recent presidential address before a scientific society the cost of cement production was placed at 12 lb. for 1 cent, or 33 cents per bbl. Where such figures were obtained is a source of wonder to the author, unless it was from the published figures given some years ago for a western plant which is now in receiver's hands and has not been operated for many years. No mill in this country is producing at this figure, which is not large enough to include fuel and labor costs alone at the majority of mills in the country. The Lehigh region is producing cement as cheaply as any district in the country and we have to strive hard to cut the total cost at the mill below 55 to 60 cents per bbl.

In the above brief review of the industry the author trusts that he has considered a few of the problems that are confronting cement manufacturers. It will readily be seen that they are almost wholly of a mechanical nature and will offer sufficient inducements to attract the members of the Society of Mechanical engineers to co-operate in their solution.

NEW PLANTS FOR SOUTH DES MOINES.

Announcements have been made of three new industries for South Des Moines. They are the plant of the Enamel Concrete Company, which manufactures machines to make enamel concrete brick and an immense new plant to be built by the Des Moines Sand Company, who have just purchased twenty acres along the river and will erect a plant to pump sand for building purposes. These, together with the new plant of the Enamel Concrete Brick Company will make three new factories for South Des Moines.

The Enamel Concrete Company will build its new plant on land along the south side of the Raccoon river. This is the site also for the new plant of the Enamel Concrete Brick Company, a subsidiary organization, which will manufacture enamel concrete brick on a large scale.

WILL INSTALL STEAM CURING PLANT.

Rollin F. Myers, of Hillsboro, Wis., well-known contractor and manufacturer of concrete blocks, is going to build an entire new factory and will install a steam curing plant. Mr. Myers has been very fortunate in securing some very large contracts for blocks for delivery this summer. He has the contract for the large bottling works building for the Hillsboro Brewery and also the engine room building for the same company. He is at the present time shipping blocks for residences for some Reedsburg parties, besides considerable local business.

Among the handsome buildings of Hillsboro is the Congregational church. This is a very ornate structure, built along gothic lines, the entire building being of concrete blocks made by Mr. Myers.

COMPLETES NEW PLANT AT COLUMBUS, O.

The Cunard Lang Concrete Company of Columbus, O., which has recently completed a new plant there for the manufacture of all kinds of concrete blocks and shapes, will have a capacity of 2,000 blocks a day. Modern machinery has been installed and the company is in a position to make any size or shape of concrete blocks.

THREE CEMENT SHOWS.

Three cement shows will be held by the Cement Products Exhibition Company, 72 West Adams street, Chicago, during the first three months of 1912. The places and dates are as follows: New York, Madison Square Garden, January 29 to February 3; Chicago, Coliseum, February 21 to February 28; Kansas City, Convention Hall, March 14 to March 21.

The addition of Kansas City show was decided upon after a letter ballot taken among the exhibitors at the previous shows. The letters received from the exhibitors indicated a strong demand for an exhibition in Kansas City in addition to those at New York and Chicago, and the Cement Products Exhibition Company determined to hold a show west of the Missouri river in March, 1912.

Kansas City is well located geographically and is a most important field from the standpoint of the maker of cement, cement products and cement machinery. Building operations in Kansas City and surrounding territory have been increasingly active year after year. The territory is so far removed from Chicago that many of those who would like to attend the Chicago show are prevented from doing so on account of the distance. An exhibition in Kansas City should draw heavily from Iowa, Minnesota, Missouri, Kansas and the southwest. Convention Hall, which has been selected for the show, is a large and convenient exhibition building. There is plenty of exhibit space and the conditions are very favorable for holding a cement show.

The three shows next year will be so arranged that exhibitors desiring to be represented at all of them may move from New York westward, taking advantage of special freight cars, which will be arranged by the exhibition company.

Preliminary plans for the shows are now under way. A number of changes in the rules and regulations are under contemplation and some changes have already been made. Previous exhibitors will be glad to learn that the management has decided to show upon each large sign furnished, the name of the exhibitor and his address, together with a short description of the business. Any additional card board signs desired will also be furnished by the management free of charge.

Although requests for space are already being received by the Cement Products Exhibition Company no applications are considered formally filed until all interested concerns and previous exhibitors are provided with complete information and given ample opportunity to make application for the reservation of exhibition space.

MARTIN ANTI-FRICTION GRATE.

The Martin Anti-Friction Rocking Grate, manufactured by the Martin Grate Co., Fisher building, Chicago, has been in service for over ten years in many of the largest steam plants of the world.

Where plain grate bars are used a very serious loss of fuel occurs from the necessity of constantly opening the fire doors to slice the fire. This results in admitting of cold air and cooling down the furnace, and also in dropping a quantity of the fine unconsumed fuel into the ash pit. This loss is prevented by the use of the Martin Grate.

The advantage of this grate over similar grates are described in an illustrated catalogue, giving at the same time the best of references by a large number of users of this type of grate.

Reinforced Concrete Condensed Milk Plant

The cost of monolithic concrete construction is largely dependent upon the cost of forms and staging. Lumber was first used and has proved satisfactory for many classes of work. But there are serious drawbacks which have caused engineers to seek a substitute material that should have all the adaptability of work to special construction and at the same time either be so cheap that it need not be a large part of the total cost of the building or else be adaptable to successive uses so that the cost of forms might be a charge against not one but many structures.

The Reichert Mfg. Co., of Milwaukee, have developed their sectional steel forms as a solution of this problem and the results in practice show a considerable saving over the use of lumber forms. They consist of sixteen gauge sheet steel plates 24 inches square, reinforced with 1-inch angles around the edges, and fitted with devices for locking together adjoining

land Center where labor cost 20 to 30 cents, the expense for staging, form erection, aligning and stripping for 90,500 square feet was $3\frac{1}{4}$ cents per square foot of wall. At Berlin where labor cost $17\frac{1}{2}$ cents, the expense for 79,800 square feet was $2\frac{1}{2}$ cents per square foot. Due to the loss of time caused by the extreme cold, the contractors are sure that the work could be duplicated in any other season of the year at 2 cents or less in each case.

Those who are familiar with the costs of erecting and stripping wood forms will realize the great saving. Of course, in any one job, the greater first cost of steel forms over lumber, would offset their more economical handling but it is not planned to use steel forms in this way. When many successive uses are contemplated, their economy is unquestioned.

The Pacific Coast Condensed Milk Co., is planning soon to erect further buildings of the same style, one



Reinforced Concrete Condensed Milk Plant at Berlin, Wis.

plates. Any thickness of wall is obtained by varying the size of separators used. After the first course of forms are set up and wired, concrete is poured and this work is followed up by another course of plates. As soon as the wall hardens sufficiently for the removal of the first set, they are raised above the second and the sets are then used alternately throughout the work.

The Pacific Coast Condensed Milk Co., have just completed two plants of similar design and size, one at Berlin, Wis., illustrated on this page, and another at Richland Center, Wis., which are excellent examples of monolithic construction, having solid reinforced walls, floors and partitions. The main buildings are 207x175 feet, two-stories high and each has a complete power plant of similar design adjoining. All walls were constructed with Reichert forms and the cost of handling them has been made the subject of an interesting study by the contractors.

Though the two buildings were similar, yet unit costs for forms differed widely, due to variations in cost of labor and to the staging being placed on the outside in one case and inside in the other. Both jobs were prosecuted during an exceedingly cold winter and the costs represent work carried out under the most unfavorable conditions. Yet they are remarkably low when compared with costs for wood forms. At Rich-

land Center where labor cost 20 to 30 cents, the expense for staging, form erection, aligning and stripping for 90,500 square feet was $3\frac{1}{4}$ cents per square foot of wall. At Berlin where labor cost $17\frac{1}{2}$ cents, the expense for 79,800 square feet was $2\frac{1}{2}$ cents per square foot. Due to the loss of time caused by the extreme cold, the contractors are sure that the work could be duplicated in any other season of the year at 2 cents or less in each case.

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McCORMICK WATERPROOF PORTLAND CEMENT CO.

No better proof for the originality of the patents on waterproofing compounds and for the efficiency of the products of the McCormick Waterproof Portland Cement Co. can possibly be found than the dismissal by order of court of the suit brought against this company by the Medusa Waterproofing Co.

CEMENT, SAND AND GRAVEL.

"Cement, Sand and Gravel for Concrete," is the title of the latest publication of the Chicago Portland Cement Co. It guides the cement user in his selection of sand and gravel—it tells how to judge, wash and screen sand—it explains why "Chicago AA" Portland cement is the best that can be made, and contains a full list of their instructive booklets, fully indorsed by the leading farm journals.

BUSINESS EXPANDING.

Due to the increase in business west of the Mississippi river, the McCormick Waterproof Portland Cement Co., of St. Louis, Mo., have opened another office in Kansas City, Mo., Reserve Bank building, room 332. Wm. H. K. Bennewitz has been appointed special representative of the company in that territory.

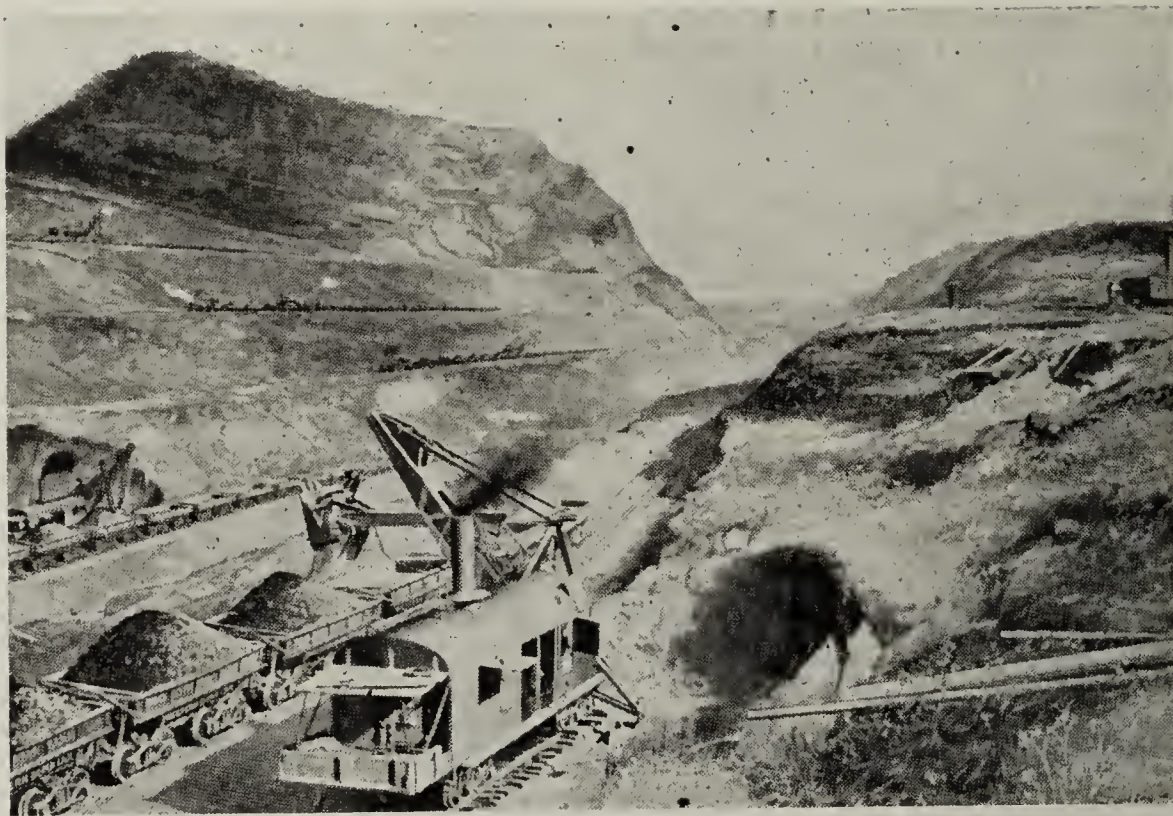
The McCormick Waterproof Portland Cement Co. has now seven offices located in the following cities, viz., St. Louis, Mo., Chicago, Ill., New York City, Boston, Mass., Pittsburg, Pa., Toledo, Ohio, and Kansas City, Mo.

Portland cement made waterproof by the McCormick process produces a concrete that will resist any water pressure to which a concrete structure is subjected. It will resist the action of alkalies, sewer gases, steam, acids in solution, and sea water. The

In the mixing of the concrete the amount of water used was approximately 13 per cent of the total volume of the cement, sand and gravel. In order to prevent the cement from flushing up into the pipe, a wooden plug was placed on the inside of the pipe and withdrawn after the cement had set.

This concrete block was aged in the open air for twenty-eight days before subjecting to a test. A hydraulic test pump was connected to the 2-inch pipe and the hydraulic test pressure increased by increments of fifty pounds. Each fifty-pound increment was held for five minutes as indicated in the tabulation below:

Pressure,
lbs. per
sq. in.
Time held,



WESTERN DUMP CARS ON THE PANAMA CANAL.

The great Culebra Cut on the Panama Canal, showing five trains of Western dump cars on different levels. This cut will be 8 miles long and 270 feet deep. The French companies removed 80 feet of the top, leaving 100 feet for the United States to excavate. The benches are 30 feet wide and about 16 feet deep. Railroad tracks are laid on each bench, and the earth and rock are hauled away by work trains. The canal is to be 300 feet wide at the bottom.

McCormick waterproofing compound is mixed with any brand of Portland cement right at the cement mill and is used on the job exactly like plain Portland cement; this is an essential factor, for it eliminates altogether the equation of labor.

A feature of interest to all is the cost. The McCormick process of waterproofing has reduced this item considerably.

The above mentioned qualities are possessed only by the McCormick Waterproof Portland Cement and account for the increased demand.

Write for reports and tests to the nearest office of the McCormick Waterproof Portland Cement Co.

REMARKABLE HYDRAULIC PRESSURE RESISTANCE OF A CONCRETE BLOCK.

Under date of March 15, 1911, the Robert W. Hunt & Co., engineers, Chicago, Ill., constructed an 18-inch cube of concrete having a mixture of one part of Portland cement waterproofed by the McCormick process, two parts of Torpedo sand and four parts of 3/4-inch crushed limestone. In this concrete was embedded a 2-inch pipe.

Minutes.		Remarks.
50	5	Without sign of dampness or leak.
100	5	Without sign of dampness or leak.
150	5	Without sign of dampness or leak.
200	5	Without sign of dampness or leak.
250	5	Without sign of dampness or leak.
300	5	Without sign of dampness or leak.
350	5	Without sign of dampness or leak.
400	5	Without sign of dampness or leak.
450	5	Without sign of dampness or leak.
500	5	Without sign of dampness or leak.
600	5	Without sign of dampness or leak.
800	5	Small sweat leak at end of 5 minutes on the bottom of cube 2 inches from center.
1,000	1	Several leaks in bottom of cube in center, running in from one side for a length of 12 inches in a straight line. Also one leak on side 2 inches from bottom of cube.

The test was discontinued at this point on account of it being impossible to maintain the pressure due to the small capacity of the test pump.

WESTERN WHEELED SCRAPER CO.

The Western Wheeled Scraper Co., of Aurora, Ill., publishes a 130-page catalogue describing and illustrating in more than a hundred cuts the various grades of scrapers, dump cars, wagons, plows and similar implements manufactured by them.

Wherever grading and filling-in is required or large amounts of rock have to be handled, this catalogue will give excellent advice and be worth sending for.

One of the cuts, which we reproduce, shows four trains of western dump cars in the construction of the Panama Canal.

our good friends by paying less than they felt was due them on sack shipments. On the other hand, we could not afford, from a business point of view, to pay out money for sacks in such bad condition that we could only throw them away or burn them up, or for sacks that we did not receive. The only alternative was to get together with our customers and help them all that we could to take proper care of their sacks and ship them in such a way that they would get back to us without loss and in proper condition for credit. The success of our work along these lines has been so great that we are anxious to extend it to channels where it will be more directly productive to our cus-



View of Small Size Crusher Manufactured by Western Wheeled Scraper Co., Aurora, Ill., as Illustrated in Their New Catalogue. It receives stone up to 9x16 inches in size, reducing from 120 to 180 tons of it to 2 inches and smaller in ten hours. The elevator delivers it to the revolving screen where it is separated into four sizes and discharged into its proper compartments in the bin, the entire operation requiring but a 15 h. p. engine.

RETURNED CEMENT SACKS.

The position of the dealer on the question of returned cement sacks is generally considered to be far from agreeable. He stands between two fires. On the one side is the consumer, who is frequently ignorant of the value of cloth sacks and of the importance of taking care of them, but who is likely to demand payment for sacks whether he returns them in good condition or not. On the other hand is the cement manufacturer, who cannot afford to pay for sacks that the dealer returns to him unless they are in good enough condition to enable them to be used again. The dealer frequently feels, therefore, that he must either suffer a loss by paying his trade for sacks that are of no use, or he must run the chance of losing the good will of his customers by refusing their demands for payment for worthless sacks.

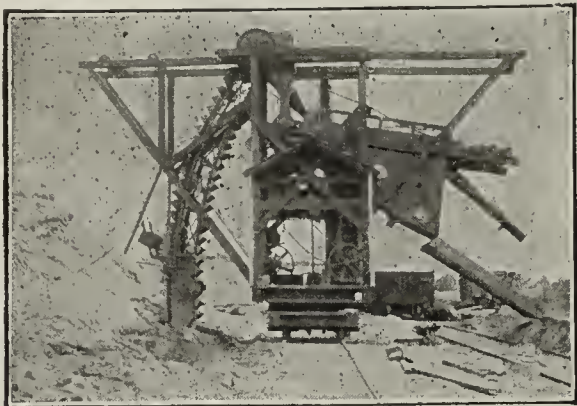
We formerly occupied about the same disagreeable position ourselves. We did not want to antagonize

tomers. The dealer who handles Universal can educate his trade to take proper care of cloth sacks, so that when the sacks are returned there will be no question about allowing proper credit for them. At the suggestion of one of our dealer friends we have gotten out a card which contains a few vital suggestions regarding the care of cloth sacks. A blank space is provided in which the name and address of the dealer supplying them to his trade may be used. We will be glad to furnish dealers who handle Universal with as many of these cards as they can distribute among their trade, with their names and addresses printed thereon. These cards may be enclosed with statements, bills or general correspondence, and if dealers will take the opportunity to impress upon their customers the importance of complying with the suggestions on the card, the result is bound to be beneficial to everybody concerned. Write us promptly and tell us how many cards you can use. (Universal Cement Co.)

PRODUCTION OF WASHED SAND AND GRAVEL FOR CONCRETE WORK.

The increasing demand for clean sand and gravel, screened and graded for use in concrete construction, is multiplying the number of plants producing such material. There is any amount of good sand and gravel lying in banks near railway connections, which would be suitable for concrete work if washed and screened. Up to recent years the cost of this treatment has been so high as to make the production unprofitable and the material has been used as taken from the bank for filling, ballast and other purposes of a similar nature.

The Superior Sand and Gravel Co. has just opened a gravel bank at Utica, Mich., on the M. C. R. R. for the mining of ballast gravel and the equipment installed is also designed to wash and screen that part of the product which is to be shipped for concrete work. A view of the bank is shown here as it was being stripped. The gravel is taken from the bank by a large machine which scoops it up, elevates it and loads it into freight cars. The machine stands upon the track nearest the bank. The gravel is conveyed to the top of the machine by chain bucket conveyor and a stream of water washes out the clay and silt as the mass en-



ters the revolving screen. The sand passing through the meshes of the screen discharges through a chute into cars on the second track and the gravel retained on the screen discharges through a pipe extending over the first car into a car standing on the third track, not shown in the view.

In this way two cars are loaded at one time, one with washed sand and the other with washed gravel. Varying the mesh of the cylinder screen governs the division of the sand from the gravel. The machine is run by steam power and is said to have a much greater loading capacity than a steam shovel, as it will load from fifteen to twenty 40-ton cars of screened sand and gravel per day. It is mounted on a truck running on a standard gauge track and the upper works are carried on a spider which allows the machine to revolve on its truck.

The plant at Utica was erected under the supervision of James H. Phinney, 301 Penobscot Bldg., Detroit, and the machine was built by the Jeffrey Mfg. Co., Columbus, O., for Shoemaker & Casparis, Newcomerstown, O., manufacturers and patentees. A similar machine is operated by the Michigan Portland Cement Paving Co. at Clarkston, Mich.

CHEMISTRY AND TESTING OF CEMENT.

Send for this latest book by Cecil H. Desch. It is the first comprehensive review, written in the English language of the research work done by the numerous cement chemists. It is up-to-date in every respect. 266 pages. Price, \$3.00.

SAND-LIME BRICK VICTORIOUS OVER FIRE.

Recently there was a disastrous fire in the city of Buffalo which destroyed the Brecker Building, which was a four-story brick, having an iron front with steel frame, while at the rear was a frame structure. The fire completely destroyed the building, and all that part of the walls which were built of clay brick were completely annihilated by the cracking and collapse of the material itself, while the sand-lime brick wall, running the entire length and about two stories, right in the center of the hottest fire zone, was itself uninjured in any way. The wall of sand-lime brick, after careful inspection after the fire was cleared away, was found to be in just about as perfect condition as as when it was first built.

There can be no better practical endorsement of the value of sand-lime brick as a fire-resisting building material.



Curb Construction with Metal Forms.

There is little argument possible against the concrete curb in the matter of time required for building, if the results obtained in the work illustrated herewith can be duplicated by the average contractor.

The Hotchkiss Lock Metal Form Co., built at Binghamton, N. Y., 137 linear feet of 6x21 inch curbing in one day with 30 running feet of forms. Five men were required for the work and none of them had used these forms except on the previous day.

The Piedmont Portland Cement Co., Candler building, Atlanta, Ga., who have just completed a new cement mill at Portland, Ga., announce that the management is so pleased with results of preliminary operation that they are going to double the capacity. It will then have a capacity of 1500 barrels per day. Electricity and steam are used for driving the machinery.

The Dewey Portland Cement plant at Dewey, Okla., which was shut down on June 30th to make repairs, will open again about September 1st.

Some Fallacies of Sidewalk Construction

By Jerome B. Landfield

A good proportion of all of the sidewalk work that is being done nowadays is constructed under the direction of engineers or in accordance with specifications laid down by them. It is, therefore, strange that there should be such a diversity in the methods employed and in results obtained. This is a curious state of affairs, considering the extent of the work and the opportunities afforded for determining to a nicety the best possible practice.

Where there is such diversity of practice it naturally follows that in some cases it is correct and in others all wrong. There seems to be a mistaken notion that sidewalk work is not deserving of serious attention, and may be properly left to the untrained man. What is true of sidewalk work is equally true of concrete curb and combined curb and gutter work. Surely this is a great mistake and municipal engineers in particular should realize that they owe it to their profession to devote sufficient attention to the subject to secure first-class results.

In this paper I desire to point out a few fallacies that have crept into sidewalk and curb and gutter work from different sources, especially those which have been sanctioned in many instances by engineers of standing.

Probably the most generally accepted fallacy is that of the cinder sub-base and it is a fallacy that has cost our cities hundreds of thousands of dollars. Did you ever stop to realize just how it came about that many of us are today specifying that a sub-base of cinders or sand should be put under a walk? In the laying of flags of natural stone the under side of the flag was nearly always irregular and to dig out and shape the natural soil to fit it was a task quite out of the question. It was far easier and more practical to fill the excavation with cinders or sand, which would naturally mold itself to fit the configuration of the under-side of the stone. What was more natural than to continue the same practice when concrete walks came to be laid, and to set up the argument that this sub-base ensured good drainage and was a safeguard against heaving due to frost?

This sounded perfectly plausible. In fact, I presume that a large portion of those who read this article will regard my view as heretical. But let me call your attention to one or two simple facts. Did you ever go out into a field in the winter time and lift from its resting place a good-sized flat stone? If so you must have noticed that there was rarely to be found beneath it any frozen ground, while all around were evidences of frost. The reason was that first of all the natural soil that formed its bed was tightly packed so as to make a snug resting place that did not admit water readily, and next that the stone itself under these conditions afforded good protection.

Now consider for a moment the concrete sidewalk. First, you dig away the natural soil, whether it be clay, gravel or hardpan, and make a trench that becomes the finest kind of reservoir to collect moisture. Then you fill this trench with porous material that never becomes as compact as the original soil, but which absorbs and holds moisture like a sponge. Of course, you tile the bottom of this trench, but this does not make the sub-base any the less a sponge.

Four or five inches of concrete would have protected the compacted natural soil that hugged it so closely as scarcely to admit any water, but severe cold is very liable to freeze the cinder foundation in spite of the concrete. These are some of the considerations that lead me to believe that the cinder sub-base is useless and detrimental, even when carefully drained with tiles, and extended practice bears this out.

Another fallacy that is very prevalent, but which is happily growing less, is the idea that a sloppy top-coat is good practice. Somehow or other many concrete men have got a notion that in sidewalk work the wetter the mix the better. They argue from experience in other kinds of work where they find that poured concrete makes a dense mass and reduces the voids and do not take into account the points wherein the conditions differ. Let us consider just what the conditions of sidewalk work are and how they affect the question of how much water to use.

In sidewalk work you do not have watertight molds in which to form your blocks. The mass you are dealing with is thin and has two large surfaces, one of which is exposed to the absorbent action of the ground beneath, and the other to the drying action of the air. If, therefore, you put too much water in your concrete there is a tendency for it to drain away and carry with it particles of cement washed from the aggregate. If less water were used and the mass well mixed, the whole amount of water would be closely engaged with the cement. In warm climates it is frequently argued that more water should be used in order that the surface may not dry out too rapidly. But here we have also a fallacy. If there is more water at the surface than is needed for the setting of the cement, there is almost certain to have been flushed to the surface considerable neat cement and as the surplus water evaporates the foundation is laid for hair-cracks. The correct way is to use the proper amount of water and then protect the surface against the heat.

The lower course should have just enough water so that it will not quake when tamped. The top coat should be mixed stiff enough so that you can mold it in the hand and it should be put on while the lower course is fresh and green. Then tamp it lightly, remove the surplus material by striking it off, and finish immediately with a wooden float. The tamping of the top coat is of great importance for fine work and it really does not add to the expense, as it simplifies finishing. The first effect is to make the top course dense and to bond it mechanically to the base. The moisture is distributed evenly throughout the mass and enough is gently flushed to the surface for immediate finishing. Where the top coat is put on as wet as mortar, or sloppy, the amount of moisture in upper and lower courses differs, and, consequently, the change in volume while setting is in different ratios. This is a fruitful source of checking.

There is one more cogent reason why the top coat should never be put on sloppy. Sidewalk differs from some other kinds of concrete work in that the surface has to be finished by manipulation. If the finished surface is to be durable it should be finished as soon as possible. Now, if the concrete is too wet, the fin-

isher stands around half an hour or so waiting for the surface to dry out enough for him to do his work. If he starts to use his trowel while it is too wet, he flushes neat cement to the surface and this, being the softest part of the mass, takes a scale that wears away easily, if it does not flake off. If, on the other hand, he waits until the surface is just plastic enough, he is bound to disturb particles that have begun to set and which for the sake of strength and durability should have been left untouched in their original positions. It is not strange that in view of these simple facts, easily demonstrated in practice, the big city of Chicago should specify a sloppy top coat for her sidewalk work.

I might point out to you a number of other minor fallacies in sidewalk work, but it is scarcely worth while they are mainly local and not wide spread. Before leaving the subject, however, I am reminded of a notion which, although harmless in itself, has stood in the way of progress in many instances. This is the notion that it is necessary to leave the forms on sidewalk work until the concrete has set, in order to protect it. Of course, the whole walk must be protected and not the edges alone, but one would not object if the contractor wished to leave the forms on his work indefinitely were it not for the fact that this notion, firmly fixed in the mind of the contractor, bars his adoption of labor-saving devices. I refer particularly to the use of steel forms or molds to take the place of lumber.

Steel forms have now come into pretty general use in different parts of the country and there is no longer any question as to their being practical and cost-saving. But their use depends upon their being employed over and over again the same day, and this means removing them while the concrete is green. Some steel forms have been developed that would allow the division plates to be taken out, leaving the side rails in place. But one has only to consider what a large supply of steel side rails would be needed for this to see the absurdity, to say nothing of the fact that taking away the division plates would make it necessary to support the side rails with stakes, one of the things steel forms are intended to obviate. There seems to be no doubt that steel forms have come to stay and so it is to be hoped that contractors will adapt their methods and ideas to follow the lines of progress.

STONE PRODUCTION.

Stone was the seventh mineral product in importance in 1909, the value of the output being \$71,345,199, according to an advance chapter of "Mineral Resources of the United States," by Ernest F. Burchard, of the United States Geological Survey. This was an increase of \$5,632,700 over the value for 1908, which was to be expected because that year was one of general depression; but it is noteworthy that the value for 1909 was greater than that for 1907, a year which was in general a record-breaker in mineral production. The value of the stone output for 1907 was \$71,105,805.

In 1900 the value of stone of different kinds produced in the United States was only \$36,970,777; in 1909 it was nearly double that figure. The general classes of stone produced in 1909 are shown in the following table: Granite, \$19,581,597; trap rock, \$5,133,842; sandstone, \$6,564,052; bluestone, \$1,446,402; marble, \$6,548,905; limestone, \$32,070,401.

ORENSTEIN-ARTHUR KOPPEL CO.

In the notable growth of the Pittsburgh Industrial District, it is interesting to note that which has recently occurred at Koppel, Pa. Nestling on a broad plateau in the midst of the Western Pennsylvania hills and overlooking the winding Beaver River, the town is the home of the American plant of the Orenstein-Arthur Koppel Company, manufacturers of portable and industrial railways and equipment.

The writer visited the place and viewed the additions and extensions that have been made within the last few months. This activity has resulted in the doubling of the plant—in buildings, ground covered and in general capacity. Another result is a healthy increase in the town's population. Koppel is on the edge of the forty-mile zone, which is popularly termed the "Pittsburg district," yet it is within the Youngstown-Sharon district, which is beginning to snare premier industrial honors with Pittsburgh.

Before the expansion movement started several months ago, the old buildings, exclusive of the two-story office building, 50x40 ft., covered a total area of 70,000 square feet. The new buildings just completed cover a total of 66,875 square feet, making a grand total of 136,875 sq. ft. Later, when the other plans are completed and the additional buildings erected the plant's inside area will aggregate almost 300,000 sq. ft.

The present plant, including the additions just made, covers a total of forty-five acres. Besides that fifty acres has been reserved for the future extension planned and twenty-five acres have been reserved for finished and unfinished stock. A total of 700 acres in and about Koppel, Pa., is owned by the Koppel Land Company and besides the 125 acres for the Orenstein-Arthur Koppel Company plant, 200 acres have been set aside for industrial purposes only, free sites being offered to manufacturers.

The Koppel Company undertook the recent building operations because they became imperative. The company has several large plants in Germany, France, Russia, Spain and Austria, where the Koppel industrial and portable railway systems and equipment are manufactured. The American business grew so rapidly that the extensions were necessary.

A MODERN CRUSHING PLANT.

The plant of the Syenite-Trap Rock Co., near Little Falls, New York, which was destroyed by fire over a year ago, has recently been rebuilt with new steel buildings and fireproof equipment throughout. The work has been done under the supervision of the General Superintendent, Mr. John Thomlinson.

The product of the Company is Trap Rock for road, concrete and railroad ballast and has a well established reputation of being the best product for these purposes in the Mohawk Valley.

The property lies on the bluffs of the Mohawk River just east of Little Falls on the north bank. The entire plant is built in the best possible manner, nothing but the highest grade machinery being used, and it will undoubtedly prove to be a well paying investment.

The officers of the company are: Emil Diebitsch, president, New York City; Walter Roberts, treasurer, New York City, and John Thomlinson, superintendent, Little Falls, N. Y.

Specifications for and Cost of Concrete Sewer Pipe at Bellingham, Wash.

By H. A. Whitney

The city of Bellingham, Wash., is using cement and concrete pipe for storm water sewers. This pipe is made under a guarantee by the manufacturers. While the city does not stipulate any process of manufacture as long as the finished product conforms to the specifications, all the cement pipe used is made by one local concern and gives satisfactory results, as compared to the vitrified clay sewer pipe. There are only two vitrified clay sewer pipe manufacturers in the Northwest, and one of those is far below the cement pipe in efficiency and tests. All sizes of pipe from 4 ins. to 24 ins. are machine made. The process is as follows:

A flask made in halves is placed around a cast iron core, in a vertical position. The cement is placed in the annular space thus formed in batches, dry mixed, having 8 per cent to 10 per cent water. As the cement is deposited in the mold it is automatically tamped with a wood tamper running at the rate of five blows per second. The core in the meantime is kept stationary while the pipe is revolved around it, thus giving a smooth glazed effect to the inside. The actual cost to the manufacturer is as follows:

4 in. pipe	4 cts. per ft.
6-in. pipe	7 cts. per ft.
8-in pipe	14 cts. per ft.
10-in. pipe	19 cts. per ft.
12-in. pipe	25 cts. per ft.
15-in. pipe	35 cts. per ft.
18-in. pipe	50 cts. per ft.
20-in. pipe	65 cts. per ft.

The above costs are based upon: Cement at \$2.30 per bbl.; sand at \$1.10 per cu. yd.; gravel at \$1.20 per cu. yard.; labor at \$2.25 per day, 8 hrs.; foreman at \$4 per day, 8 hrs.

The pipe as sold, delivered upon the line of work at the following rates:

4-in. pipe	11 cts.
6-in. pipe	16½ cts.
8-in. pipe	22½ cts.
10-in. pipe	32 cts.
12-in. pipe	40 cts.
15-in. pipe	60 cts.
18-in. pipe	75 cts.
20-in. pipe	90 cts.

The difference in manufactured and delivered price, represents hauling, breakage and profits.

Several laboratory tests were made on cement pipe, and vitrified clay pipe, four samples of each were tested. Six, 8, 10 and 12 in. pipe, cement pipe, burst under about 60 lbs. pressure, although they started sweating at about 7 lbs. pressure. One made of the clay pipe products at 1½ lbs. pressure, spurted small needle-like streams of water from innumerable pin holes, and at about 35 lbs. pressure would split.

The other make of clay pipe was far better, no loss due to percolation occurred under 16 lbs. The breaking occurred at about 65 to 70 lbs. This latter product of clay pipe was superior in our tests to the cement pipe, but the former clay pipe was not to be considered. The following are the specifications upon which bids for concrete pipe are received:

Make—All cement pipe shall be machine molded and what is known as bell and spigot type. All pipe 10 ins. and larger in diameter shall be reinforced with a wire netting or some approved method. The manu-

facturers to give the City Engineer a sketch of what method and sizes of reinforcement of their different pipes.

Grade—All pipe must be equal in all respects to the samples on record at the City Hall, no deviation allowed unless by written order of the City Engineer.

Quality—When broken the pipe shall appear homogeneous throughout, and be entirely free from cracks or voids, and generally uniform, showing pieces of fractured stone firmly imbedded in the mortar, where stone enters into the composition.

Composition—The clearance between the bell and spigot must be ample to allow a proper mixture of cement mortar to be placed in the annular space thus formed. The inside diameter of the bell shall not be less than ¾ in. greater than the outside diameter of the spigot. The following table shows what shall be the minimum sizes of pipe and mixtures of sand, cement and gravel used.

Table of Mixtures and Sizes for Cement Pipes.
Thick-

Size, ins.	Thick- ins.	Cement.	Sand.	Pea gravel
6	7/8	One part	Two parts	None
8	1 1/8	One part	Two parts	None
10	1 1/4	One part	Two parts	None
12	1 1/2	One part	Two parts	None
15	1 3/4	One part	Two parts	One part
18	2	One part	Two parts	One part
21	2 1/4	One part	Two parts	One part
24	2 1/2	One part	Two parts	One part
30	3	One part	Two parts	One part

Cement—The cement shall stand the prescribed test of the American Society of Civil Engineers.

Sand—The sand shall be clean and not more than 235 per cent shall pass over a No. 40 screen, and all shall pass through a No. 4 screen.

Gravel—The gravel used shall be clean and not less than one-quarter inch in diameter and not greater than one-half inch in diameter, measured over the greatest diameter. Should any of the above mixture not conform to the specifications it may be all rejected.

Markings—All pipe shall have marked on it the date of molding and the maker's name. When so requested the contractor shall deliver to the City Hall such samples as the City Engineer may call for.

Tests—Pipe laid upon a compact and even bearing of sand without side displacement shall stand a test of 1,000 lbs. per lin. ft. up to and including 10 in. pipe, 1,300 lbs. for 12 in. and 15 in. pipe; 1,600 lbs. for 18 in. and 20 in. pipe; 1,800 lbs. for 21 in., and 2,000 lbs. for 24 in., applied the whole length of pipe exclusive of bell. Untreated pipes shall show no percolation up to 15 lbs. per sq. in. and shall resist fracture at 50 lbs. per sq. in.

Drop Weight—Pipe supported on a dry sand bed 2 ins. deep shall withstand without cracking the impact from two blows from a cast iron ball or similar object weighing 6 lbs., falling 18 ins. This test may be applied on the line of work. Any pipe at any time that is deemed unsatisfactory to the City Engineer shall not be used upon the work and the same shall at once be removed and satisfactory pipe furnished in its place. No pipe shall be delivered onto the work within 30 days after being molded.

Street Curbs

By Irving W. Stoddard, C. E.

At the present time there are being used two general types of street curbs: namely, the straight curb and the combined curb and gutter. The straight curb is constructed of concrete, cut stone, or wood, and in some rare cases, of burned clay and cast iron. The latter has been used to a limited extent in Europe, and the burned clay experimentally in this country. The combined curb and gutter is always constructed of concrete.

The combined curb and gutter is now coming into very extensive use. In past years it has not been used where traffic was great, as in the business district of cities, chiefly because the concrete was not supposed to be able to stand the wear. In very recent years, however, the increasing use of concrete pavements has led to the much more extended use of the combined curb and gutter.

The combined curb and gutter has advantages over the straight curb, owing to the fact that the gutter is of the same material as the curb and is a part of it. This presents an easy passage for water, and makes possible the narrowing of the street paving from three to six feet, thereby effecting a material saving as the gutter is, as a rule, considerably cheaper than the paving.

It is a common practice to batter the face of street curbs, and to round the outside edge. The height of face in each type of curb varies from four inches to ten inches. In the case of the combined curb and gutter, the face is often battered, and the intersection of the face with the gutter is rounded. This tends to throw wheels running in the gutter away from the face, thus preventing excessive wear. The gutter is from a foot and a half to three feet wide, and the top of the curb is usually six inches thick.

The concrete for the combined curb and gutter is often in the proportion of 1:3:5, with stone an inch and a quarter to an inch and three quarters as a maximum. These proportions are also sometimes employed in the straight curb, but it is also very often made of 1:3 gravel concrete. In both cases a wearing surface from a half inch to an inch in thickness, composed of 1:1 mortar is very common. As in the case of any concrete subject to impact and abrasion, the proportions must be exact and the mixing thoroughly done.

Curb foundations usually consist of from three to six inches of sand, gravel, or cinders, from three to six inches wider than the curb on each side.

The forms are most often of wood, although there are patented steel forms on the market. They are staked firmly at intervals of about two and a half feet, and are set exactly to grade. For the curb alone the forms are two, one for the face and one for the back of the curb, but for the combined curb and gutter, a third form may be used for the edge of the gutter. In case the three forms are used, the concrete is placed and finished by a wooden float and trowel, and is properly edged before the face form is removed.

A very economical and highly satisfactory method of finishing a combined curb and gutter is by means of a curb machine. Where a machine is used, the front and back forms are necessary as before, and steel templates, somewhat smaller than the cross section of the finished curb, are placed at intervals of from five to eight feet. On these templates there is placed what some contractors call a "jumbo," simply a 4-in. by 6-

in. timber. This is firmly clamped to the back form, separated from it by the steel templates, making the form for the face of the curb. The base concrete is deposited in layers and thoroughly tamped. The top is roughly edged and the "jumbo" removed. The location of the templates is marked on the forms and they are now withdrawn. On the base thus laid is placed the wearing surface of mortar which is given the proper shape by the machine.

The curb machine is a device of wood and sheet iron, shaped exactly like the top of the cross section of the finished curb. It rests on top of the front and back forms, and is pushed along thereon, leaving the curb and gutter properly shaped. After the surface coat has set for a short time, it is cut through where the templates were, and is gone over with a trowel and edgers. The final surface is either smooth as the trowel leaves it, or it is brushed.

An examination of data from a large number of cities in Iowa, ranging in size from 3,000 to 20,000 shows the price of curb to vary from 27 cents for straight curb, to 80 cents for combined curb and gutter.

Cross Sections of Curb Now in Use.

Below is presented a table giving data regarding curb now being used:

Albia, Iowa:

Type of curb.....	Combined curb and gutter.
Foundation	4 inches sand.
Forms	2-inch dressed plank.
Material—Base	1-3-5-concrete. Stone 1¼-inch maximum.
Surface..	1-1 mortar.
Finish	Carlson's patent and brush.
Expansion.....	Cut into 5-ft. blocks.
Expansion	½-inch sand filled joint every 50
Price per foot.....	ft. 62c.

Centerville, Iowa:

Type of curb.....	Combined curb and gutter.
Foundation	4 inches cinders.
Forms	2-inch dressed plank.
Material—Base	1-3-5-concrete. Stone 1¼ maximum.
Surface..	1-1 mortar.
Finish	Wood float trowel and brush.
Expansion	½-inch pitch filled joint at 50 ft. intervals.
Price per foot.....	

Clarinda, Iowa:

Type of curb.....	Straight curb.
Foundation	No special.
Forms	2-inch plank.
Material—Base	1-2-4-concrete. Stone 1-in. maximum.
Surface..	1-1½ mortar.
Finish	Trowel on top.
Expansion	Cut into 6 ft. blocks.
Price per foot.....	37½ cents.

Clinton, Iowa:

Type of curb.....	Straight curb.
Foundation	12 inches cinders.
Forms	Lumber or steel.
Material	1:3 gravel concrete.
Forms	Trowel on top.
Expansion	⅛-in. joint at 6 ft. intervals.
Price per foot.....	55c to 60c.

Creston, Iowa:

Type of curb.....Straight curb.
 FoundationDirt compact.
 Material1:3 sand 25% gravel over $\frac{1}{4}$ in.
 FinishTop troweled.
 ExpansionSeveral layers of tarred paper at 20 ft. intervals.

Dubuque, Iowa:

Type of curb.....Combined curb and gutter.
 Foundation6 inches cinders or crushed stone.
 FormsPlank.
 Material1-3-5-concrete. Stone $\frac{1}{4}$ in. to $1\frac{1}{4}$ in.
 FinishTrowel and brush.
 Expansion $\frac{3}{4}$ -in. joint at 150 ft. intervals.
 Price per foot.....62c to 85c.

Mason City, Iowa:

Type of curb.....Straight curb.
 Material1:2 gravel concrete.

Muscatine, Iowa:

Type of curb.....Combined curb and gutter.
 FoundationNo special.
 FormsPlank.
 Material—Base1-3-5-concrete.
 Surface..2-3 mortar.
 FinishTrowel.
 Expansion $\frac{1}{4}$ -in. between 5 ft. sections and $\frac{3}{4}$ -in. joint at 30 ft. intervals.
 Price per foot.....57 $\frac{1}{2}$ c to 60c.

Mt. Pleasant, Iowa:

Type of curb.....Combined curb and gutter.
 Foundation6-in. sand or fine gravel.
 FormsPlank.
 Material—Base1-2-4 stone 1-in. maximum; no dust.
 Surface..1-1 mortar.
 FinishCarlson's patent and trowel.
 Expansion3 joints in city block.
 Price per foot.....65 $\frac{1}{2}$ c.

Oskaloosa, Iowa:

Type of curb.....Combined curb and gutter.
 Foundation6 inches cinders.
 FormsPlank.
 Material—Base1-3 gravel concrete.
 Surface..1-1 $\frac{1}{2}$ mortar.
 FinishCarlson's patent.
 ExpansionCut through at 5 ft. intervals.
 Price per foot.....63c.

Red Oak, Iowa:

Type of curb.....Combined curb and gutter and straight curb.
 Foundation3 inches cinders.
 FormsPlank.
 Material—Base1-2-5-concrete. Stone $1\frac{1}{2}$ -in. crusher run.
 Surface..1-2 mortar.
 Tarred paper joint at 20 ft. intervals.
 Expansionvals.

Sioux City, Iowa:

Type of curb.....Combined curb and gutter.
 FoundationDirt.
 FormsPlank.
 Material—Base1-3-5 stone $1\frac{1}{2}$ -in. max. crusher run.
 Surface..1-2 mortar.
 FinishWooden float.
 Expansion75c to 80c.
 Price per foot.....Joint at 100 ft. to 150 ft. intervals.

Spokane, Wash.

Type of curb.....Straight curb.
 FoundationDirt.
 Material—Base1-3-5-concrete.
 Surface..1-2 mortar.

Vinton, Iowa:

Type of curb.....Straight curb.
 FoundationDirt.
 FormsPlank.
 Material1:3 gravel concrete.
 Trowel.
 ExpansionNone provided.
 Price per foot.....36c.

Waterloo, Iowa:

Type of curb.....Combined curb and gutter.
 FoundationNo special.
 FormsPlank.
 Material—Base1-4 gravel concrete.
 Surface..1-1 $\frac{1}{2}$ mortar.
 FinishTrowel and brush.
 ExpansionThree 1-in. joints in city block.
 Price per foot.....60c.

Men have been put to work at the plant of the Mar-engo Portland Cement Co., at Caledonia, N. Y., a bankrupt concern of which H. W. Rippey of Rochester, is trustee, grinding up the supply of clinker on hand, which will make 5,000 barrels of cement. The receipts from its sale will be applied to paying off the claims of the employees.

Charles A. Newhall, B. S., who was recently employed as chemical engineer for the Superior Portland Cement Co., at Concrete, Wash., has gone into business for himself at Seattle, Wash., where he has opened an office and laboratories in the Northern Bank and Trust Building.

MATERIALS REQUIRED FOR ONE YARD OF CONCRETE.

Dealers and others having occasion to order materials for concrete, must often estimate quantities, knowing only the volume of completed work and the mixture to be used. The following table will be of help and is of sufficient accuracy for all ordinary uses.

Mixture	Cement (Barrels)	Sand (Cu. Yds.)	Stone (Cu. Yds.)
1-2 -3	1.83	0.51	0.77
1-2 -4	1.57	0.44	0.88
1-2 $\frac{1}{2}$ -5	1.29	0.45	0.91
1-3 -5	1.22	0.51	0.86
1-3 -6	1.10	0.46	0.93

To order material for a job that figures, for instance, 200 yards of concrete of a 1-3-5 mixture, it is only necessary to use the above table as follows: Opposite the mixture 1-3-5 of the first column are the factors 1.22 for cement, 0.51 for sand and 0.86 for stone.

Each yard of concrete will require—

1.22 barrels of cement
 0.51 cubic yards of sand
 0.86 cubic yards of stone

The total for the work will be—

200x1.22—244 barrels of cement
 200x0.51—102 cubic yards of sand
 200x0.86—172 cubic yards of stone

In all concrete work there will be a certain waste of materials such as partly used batches and lost materials, for which allowance must be made over the above quantities. The amount of the waste will vary greatly with the different classes of work and the care of the workmen.

Concrete Honesty

By C. A. P. Turner, Minneapolis, Minn.

An objection to the adoption of reinforced concrete frequently urged by the old-fashioned engineer and architect is that the contractor is so dishonest that he will skin a little cement here and there and the integrity of the resulting structure will be doubtful.

Unfortunately, this old-fashioned engineer and architect is not sufficiently familiar with the first principles of reinforced concrete construction, and his objection on this score is rather amusing since if he

amount of lumber required for centering and the additional time that it would require to finish the building. In other words, reinforced concrete construction is a line of business in which the work can be executed honestly at a lower cost than would result from an attempt to dishonestly use an insufficient amount of cement in the mixture, and there are few contractors who are so ignorant, after they have put up three or four buildings, that they fail to appreciate



Royal Insurance Bldg., Northwest Corner Pine and Sansome Sts., San Francisco, Cal. All Castings Used for Trimming This Building Were Executed in Medusa White Portland. Bricks Were Set and Pointing Done with White Medusa Mortar. Howell & Stokes, Architects. Thompson-Starrett Co., General Contractors.

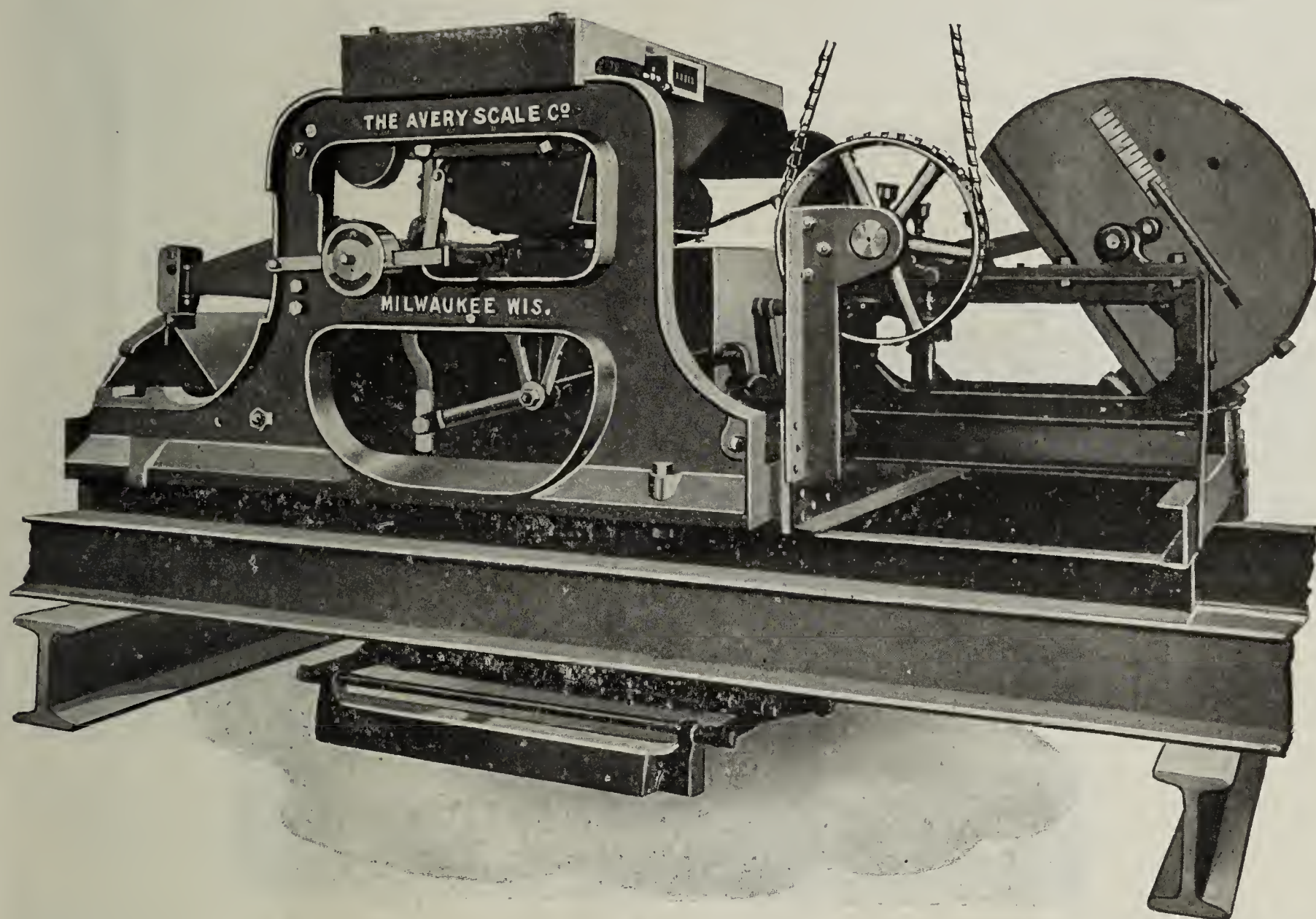
credits the average contractor with any intelligence whatever he should be aware of the fact that it is impossible to reduce the necessary amount of cement in the mix without requiring the temporary work or timber forms to be left in place a greater length of time than would be required with a richer and better mixture. What the contractor could possibly save in cement he would lose four times in the additional

this important characteristic of concrete construction.

On this question of dishonesty, of which the old-fashioned engineer and architect is wont to accuse the general contractor, on general principles if for no other reason, a word or two may not be amiss.

The speaker's business is, to a large extent, that of consulting expert for a large number of general contractors and builders. He has learned to appreciate

THE AVERY AUTOMATIC CLINKER SCALE WITH GYPSUM MEASURER



This machine will automatically weigh the clinker coming from the kilns, and also add the desired percentage of gypsum. Every cement manufacturer knows the importance of having a record of the amount of clinker which he uses, and also is fully aware of the importance of having the correct quantity of gypsum added to the clinker in order to enable him to turn out the desired grade of cement.

The above machine automatically weighs a fixed quantity of clinker each discharge and the measurer delivers a certain percentage of gypsum according to the manner it has been adjusted. The gypsum measurer is usually arranged so that it can deliver from one to five per cent of the clinker as the manufacturer desires.

FOR FULL PARTICULARS AND QUOTATION WRITE

THE AVERY SCALE COMPANY
North Milwaukee - - - Wisconsin

their integrity by constant dealing with them. They desire to do work which will be creditable to their reputation as constructors. They have learned the lesson that a good reputation as a builder is a most valuable asset commercially, and that they cannot afford to lose this reputation by failure to make good. They have learned it to be a fact that the larger profit in the line of construction is secured by scientific and systematic management of the work; by looking sharply after the purchasing, seeing that the materials are delivered when they are needed to push forward the work, and suitable equipment is supplied and on the ground for the economic execution of the work, and that everything is carried on in an orderly and systematic manner, planned and laid out in advance. By so doing, the cost of executing the work may be kept down to a minimum.

These men, in paying the bill for the cost of construction, are inclined to check up rigidly their ideas of theoretical economy with cold figures as to what the work has actually cost, by carrying it out along different theoretical lines. They pay the bill, and in doing so, the results secured guide them in their judgment.

brick machines, finishing tools, as well as appliances, waterproofing, coloring, etc., during the big exposition this fall. In fact, every modern cement product and all the improved machinery and appliances for producing them will be shown at the Oklahoma State Fair.

Practical demonstrations and scientific tests of cement products and appliances will be made every day. Experts in all lines of cement handling will deliver lectures and answer questions on subjects of vital interest to every one interested in the industry. The general public is urged to come and learn more as to the many advantages of cement construction over the use of other materials.

Manufacturers of cement products all over the United States are recognizing the grand opportunity the Oklahoma State Fair offers to show their products to the people. Every mail brings any number of inquiries as to space, etc. Manufacturers of concrete machinery and building materials also know the value of such exhibits and will be represented when the gates of the big show are thrown open on September 26. The ground floor plan of the building is in the 1911 catalogue which is now being distributed.



FOUNTAIN AND COURT.

Residence of C. E. Finlay, Kensington, Great Neck, L. I. Medusa White Portland Used. Stone-Steel Co., Builders, New York and Albany.

CEMENT SHOW AT OKLAHOMA CITY.

Oklahoma City.—One of the big features of the Oklahoma State Fair, Oklahoma City, September 26 to October 7, 1911, will be the exhibits of cement industries, including manufacturers of concrete machinery. Oklahoma is eighth in the rank of production, according to the United States geological survey. By this it is meant that the value of the output of something like two million barrels of cement in 1910 was exceeded only by the state producing precious metals, coal and other fuel products, clay and stone.

The State Fair Association of Oklahoma recognized the steady growth of the cement industry in Oklahoma four years ago and erected a substantial building as part of the big State Fair plant. It is 60x160 feet and contains no less than 7,500 square feet of floor space, which will be devoted exclusively to the display of concrete mixers, cement posts, block machines, burial vaults, stock tanks, well tile, cement

A copy of the premium list will be sent on application to I. S. Mahan, secretary, Oklahoma City, Okla.

LUMBERMEN'S PORTLAND CEMENT PLANT SOLD.

The entire plant and assets of the Lumbermen's Portland Cement Company were sold at public sale by C. H. Apt, the receiver, at the plant in Carlisle, Kans., today. The property was bid in by C. L. Hogan and Arthur W. Burns of Kansas City, representing the reorganized company, for \$268,000. As soon as the sale is approved by the court the plant, now partially constructed, will be completed and operated. The company has been in the hands of a receiver for about six months. Charles L. Hogan is manager of the Lumbermen's Portland Cement Company with offices in the R. A. Long building, Kansas City, Mo.



*Concrete Water Tower, Made
Perfectly Waterproof with
Ceresit Waterproofing*

Ordinary Waterproofing Compounds Weaken the Concrete Mass

Many engineers refuse to allow waterproofing powders to be used on their concrete construction, because the powders do not unite properly with the cement, sand and stone. They waterproof the concrete only in some spots and expose it in others. Nor will they allow mere washes or paints to be used, because they crack, peel and chip off, exposing the surface to the entrance of moisture and disintegration from frosts.

To effectively waterproof concrete, you must incorporate a highly efficient water repellant uniformly in the entire mass and the best known method is by Ceresitizing the concrete during the mixing of the cement, sand and stone.

"Ceresit" Waterproofing

Is an Integral Waterproofing

sold in the form of a cream white paste which is put into the water which is to be used in mixing the concrete and before the mixing is done. This Ceresitized solution of water is used, instead of plain water, in mixing the concrete ingredients and this solution carries the Ceresit water-repellant into every portion of the mixture. When the concrete mixture is completed it is uniformly waterproofed through and through.

Whether the concrete wall be six inches or six feet thick it is waterproofed throughout the entire mass and no water will ever get into it. Mere scratches or chips on the surface do not affect the water repelling quality of the Ceresitized mass.

The leading engineers in Europe and America recognize in **Ceresit** the most effective water resistant at the lowest possible cost. These men have used it on tunnels, dams, reservoirs, swimming pools, sewers, foundations, bridges, aqueducts, viaducts, water towers, water tanks, cellars, floors, roofs, etc., etc.

No water pressure that **Ceresit** is required to withstand will affect its permanent water repelling properties. Continued pressure and age tend to increase the water resisting quality of Ceresitized concrete.

Ceresitizing is an absolutely trustworthy and safe method of keeping water out of the thinnest cement mortar coating that is ever used on structures built of concrete, brick, stone, tile, and for stucco and cement plaster surfaces.

We guarantee **Ceresit** to permanently keep water out of any concrete or cement construction when the work is done under our direction.

Ceresit is sold all over the world in barrels, and five and ten gallon jacketed cans.

CERESIT is Catalogued in "Sweet's" Index, Pages 46-47

CERESIT WATERPROOFING COMPANY

Corner Clark and Adams Streets, Chicago

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REMINDER

to write for Free Book "Q" on how to effectively and permanently waterproof concrete and cement mortar.

CERESIT WATERPROOFING CO.

Cor. Clark and Adams Sts., Chicago

Mixing Lime Mortar

One of the most serious drawbacks to our construction ideas in this age, is that we are too much hurried in our method of constructing buildings, and with the natural sequence that many of them fail to withstand the test of time, making many an otherwise noble effort unworthy the labor and expense.

Of course, this is not due to one or another material singly, but there is something very nearly akin to negligence in this respect, and the greater the care that is bestowed on every detail the more certain are we to find that we have not worked to an end that means failure. There should be more particular care bestowed by all those who are connected with the various parts of the undertaking, and this applies to architects, contractors, builders, laborers and lastly to those who are the owners of the structure itself.

Let us take a single item in the construction of buildings, that of mortar or plaster. It is the common custom to make a batch of mortar on the street, at least for the general run of buildings, one day and to use the same the day following, or at least within a few days, and then to look for excellent results. It is as impossible as anything in the world could be, and the reason is so simple that any man who has a reasonable knowledge of lime and its nature should well know that there is the barest possibility of the outcome being satisfactory.

Let the facts be made plain. Take the lime and make a mortar bed, with an outside bank of sand. Put in your lime, then add the required amount of water. Immediately the lime begins to slake. This is caused by the lime taking on an amount of moisture equal to that which was lost when the carbonic acid gas was driven off by the heat in the operation of burning the limestone. When this moisture has been absorbed the lime is said to be slaked, or hydrated, as the more modern term is called. This may apparently take but a day or so, and it seems reasonable to view the matter in this light, but this is where the error has and continues to be made by so large a number of builders today. The chemical action of the lime has just begun, and it will require more than six months under favorable conditions to properly slake lime, so that the mortar will be in condition to be placed on the wall and remain intact.

The fault may be with the lime in the first place, and can be due to a poor quality of lime, caused by over-burning or under-burning, both of which are serious detriments to the lime itself. But this will not be improved by the rapid use of the mortar, and the results of so many of our plastering jobs being unsatisfactory is due to this hurried method of making mortar.

In some countries, Germany, for instance, there is only a limited amount of mortar used that has not been allowed to remain slaked for at least six months. It is the usual custom there to dig wells in which the mortar is placed, so as to permit the chemicals to undergo all the changes that are possible, which generally requires several months at least, and in this way the life of the mortar is insured, and the work of the builder proves satisfactory. The lime has been put to a test that will be the most helpful thing pos-

sible to insure its good qualities and at the same time prevent the possibilities of the plaster from becoming lifeless, due to the continual changes that are going on from the fact that the lime was not permitted to slake properly.

In most of our American cities the custom prevails that the quicker a job is complete the better will it please the owner and the owner, as a rule, is the most impatient person in the world. There is only one way in which this difficulty can be met and overcome, and that is the adoption of laws in each city covering this point. There are good and sane reasons why this should be done, and the architects and builders should give the matter some consideration. The blame naturally falls on their heads when the plastering is found unsatisfactory and the reason seems to be entirely overlooked. Any commodity that is subject to chemical changes must be thoroughly understood and handled accordingly before there can be gained the results that will prove satisfactory to those using the same. Lime is one of these and there is room for more care in the making of mortar, which seems too often to be a mere trite operation.

In making mortar, how few contractors give it the attention they should. In so many instances they are satisfied to permit an ordinary workman, one who has no idea of the importance of his undertaking, to superintend the whole operation. He may be careful, and he may not be, but in any event he does not understand the importance of his work, and with the exception of what meager experience he may have gained from his labors about buildings, has no idea of what he is doing. He judges by this instinct how much water to add to the lime, and how long it should remain before using. The builder is satisfied to take his view of the matter, and the result is too often displeasing to the owner of the structure, and justly so.

There is still another thing that should be taken into consideration, and that is the importance of having a filler for the lime in making mortar. Ordinarily, because it is plentiful, and consequently cheap, sand has been used to a great extent, and while it has given a fair amount of satisfaction there are other ingredients that give much more lasting effects, and that are also very cheap. These include crushed cinders and crushed limestone, either of which has been found to make a most hard and lasting filler in the plaster. In fact, there have been cases where the plaster was found to be equal to that of cement, where either of the above ingredients were used in connection with the lime.

There should be far more care given to the subject of mortar, and the fact that it is used the day after being made will be found to be the chief cause for its rapid disintegration. Care should also be used in the selection of the materials. The most desirable kind of lime is the medium burned. It is not as dark as the lightly burned lime, and when a naturally white lime will stay white when made up for plaster. It will slake very rapidly, and will be found to give the most perfect satisfaction. Clean, sharp sand, where sand is used, or crushed stone or crushed cinders should be selected with care.

Give the matter of mortar as much consideration as you would to any other portion of the house, and there will be far less complaints, many of which are just, and there will also be a much greater amount of satisfaction among all those who are vitally interested in the building industry. Urge the adoption of laws to compel the proper slaking of mortar, and the results will be of real practical durability.

PERMANENCE OF CONCRETE WORK.

Caution is always advisable in the employment of any new material of construction whose behavior, especially under unusual conditions, is not fully known from experience.

During recent years the employment of concrete made from Portland cement, and of reinforced concrete, has found many and extensive uses in con-

struction work in and about mines. In its wide and varied application concrete is a comparatively new building material, and engineers are warranted in being suspicious of it for certain important permanent work.

Numerous failures of concrete walls and other structures are on record, where, even after service of only a year or so, the structures have cracked or have begun to disintegrate. In other cases concrete and reinforced concrete structures have remained intact for years and show every indication of permanent stability. The question naturally arises, why this difference? Investigations of individual cases show that failures are usually due to one or more of the following causes; poor quality of cement, poor quality of the stone or other materials with which the cement is mixed to faulty mixing, to incorrect proportion of cement sand, stone and water, or to improper placing.

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Experience shows that concrete that has been properly made, from the best materials and properly laid, makes a strong and durable building material, that is adapted to a wide range of uses under many conditions.

Concrete to give satisfactory results must be used intelligently and the materials and workmanship must conform to certain well established requirements, hence the importance of entrusting such work only to men who thoroughly understand these requirements and will see that they are observed.

In mining work concrete is finding more and more extensive use, both above and below ground, where conditions are such as to make its use particularly desirable. Doubts have been expressed, however, as to the lasting qualities of concrete in mines where it comes in contact with acid water. This matter has been under investigation for a number of years by the mining department of the Delaware, Lackawanna & Western railroad. The conclusion reached from these tests is that concrete made from proper materials is not affected by mine water.

The tests were made with water that contained about one-fourth of one per cent of sulphuric acid. As these tests were of comparatively short duration and did not cover all conditions of mine waters, they cannot, therefore, be accepted as conclusive. They indicate, however, that acid waters do not have a marked deleterious effect upon good concrete. The results of longer tests under more varied conditions will be welcomed. In the tests referred to it was found that porous concrete and concrete made with slate and "bony" deteriorated rapidly in the acid water, emphasizing the necessity for observance of rigid requirements for concrete construction.

CARDIFF TILE MACHINE.

The making of concrete tile can be carried on as a profitable side line, even if one does not care to adopt it exclusively. Wherever there is sand and gravel, there is an opportunity for turning out this product, which is well worthy of consideration by all cement men, such as block makers, sidewalk builders, paving contractors and ditching contractors, and even by lumber dealers and others.

A tile machine which will involve only a small outlay of capital is the "Cardiff" Tile Machine, so named after its inventor and patentee, Mr. John Cardiff. This machine was exhibited at the Chicago Cement Show in February, and attracted much attention. It is made by the Leavitt Manufacturing Co., of Urbana, Ill. Its construction and operation are so simple that any factory can put it in and start making tile. A farmer who has spare time, and whose hired men have intervals between other work, can use one of these machines to great advantage, and will reap large returns for the effort expended. Any employer, in fact, can use one to make money at odd times when his men have no other more profitable work. The machine has demonstrated its worth as a profit-builder for rainy days. It offers a most attractive opening for a small investment. Write the company at Urbana for descriptive circulars and terms.

The new plaster mill at Alabaster, Mich., commenced grinding plaster last week. The new plant, which replaces the one burned last fall, is one of the very best in the country, being modern in every detail.

The rebuilding of the plant of The Whitehall Portland Cement Co., at Cementon, Pa., is progressing rapidly and it is expected to have the mill in operation by September.

A COMPLETE TILE PLANT For \$75⁰⁰

THIS headline should interest YOU for at least four good reasons. The Tile business is in its infancy and there is a steady growing demand in all parts of the country.

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The machinery we are offering is of the very best type that can be produced and is guaranteed to give you better results than any other like equipment on the market.

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Let us put more information regarding this great enterprise at your disposal for we feel that the more you learn about it—the better it will look to you.

Write Today

THIS most extraordinary price includes the following equipment: The Schenk Junior Tile Machine, with complete equipment for making four-five-six-eight-ten and twelve inch tile. It has a capacity of from 500 to 700 tile per man and can be operated by one or six men.

The Perfection Concrete Mixer, Number One, on skids. Capacity 30 to 40 yards.

The S. & S. Horizontal Hopper-cooled, Six-Horse Power Gasoline Engine. Twenty feet of shalting, fifty feet of 6-inch rubber belting, twenty-five feet of 4-inch rubber belting, four post hangers, and three wood-split pulleys.

We want YOU to know more about this great price proposition, so have prepared the matter in concise form under the title, "Cement Tile Equipment at factory cost plus (+)". Your copy is now ready.

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CEMENT

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ENGINEERING NEWS



Exhibit of Medusa White Portland Cement.

CEMENT AND ENGINEERING NEWS

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JOHN F. WALDRON - - - - - Advertising Manager

CHICAGO, SEPTEMBER, 1911

SAND-LIME BRICK.

This issue contains the last installment of the translation of Messrs. E. Leduc & Ch. de la Roche's important work on "Sand-Lime Products," describing the most thorough research work ever conducted on sand-lime materials or artificial sandstone.

The intense interest in this publication manifested by a great number of sand-lime brick manufacturers and the numerous congratulations we received upon having carefully re-calculated the many valuable tables which accompany the comprehensive work and upon having presented it to the American cement world, will induce us to publish also in the future similar researches and to contribute furthermore towards a correct understanding of the principles underlying the process of manufacture of a product rapidly growing in favor with architects.

The similarity between concrete blocks and sand-lime products has been pointed out now and then. Formerly chemists not conversant with the processes of hardening going on in both products attributed the hardening of cement and of a mixture of sand and hydrated lime to different causes, but today every one initiated in the working of cement materials knows that the action of hydrated lime upon silica is the main factor in the hardening of all calcareous hydraulic cements and, of course, the sole factor in the hardening of sand-lime products. The hardened product is the same, only obtained in a different way, namely by decomposition of the ingredients of the cement clinker in one instance, and by direct combination, under high-pressure steam, in the other.

Both processes lead to good marketable products, to concrete block and to sand-lime brick or artificial sandstone. All that the manufacturers of both kinds of building stone have to do is to keep their artificial stone up to a certain standard and to embody in them, by a skillful process of manufacture, the properties intrinsic to the natural stone they are imitating, namely a sufficient density and resistance to compression.

As the cement block industry is steadily growing, so the manufacture of sand-lime brick will increase in this country from year to year. There is room for both products, so much the more as the tastes of architects differ widely, thus calling for different kinds of artificial stone possessing the same strength and imperviousness, but varying slightly in exterior finish.

SAND-LIME PRODUCTS.

By E. Leduc & Ch. de la Roche.

(Continued from page 266.)

Effect of an Admixture of Powdered Glass: As demonstrated in former chapters, fine grinding of the sand increased the strength of the sand-lime product, because the combination of lime and sand was greatly facilitated by it.

If silica of extreme fineness increases the strength, the same object can be obtained by an admixture of finely ground silicates which are easily decomposable.

If soluble sodium silicate is added to the mixture of sand and lime, solid calcium silicate is formed almost at once, as the reaction between lime and alkaline silicates progresses with great rapidity. For this reason, a similar admixture is commercially impossible; it can not be mixed and moulded fast enough.

However, instead of alkaline silicates, finely powdered glass can be used to great advantage.

Steam under pressure decomposes glass completely. A mixture of hydrated lime and powdered glass, therefore, forms calcium silicate of such strength that it excels even glass.

Table XXIX and table XXX illustrate the resistance obtainable with mixtures of hydrated lime and glass or with powdered glass, lime and sand. From these figures will be seen that a relatively small proportion of glass increases the strength of a sand-lime mixture considerably.

Results Obtained with Admixtures of Puzzuolana: We made likewise experiments with admixtures of puzzuolana, as we hoped to increase the strength of the sand-lime mixture by a relatively small addition of volcanic products containing free silica. However, our tests made with "gaize," previously heated to 600-700 centigrade, showed that a rather large percentage of it was required and that even then the strength was increased but slightly (see table XXXI).

Behavior of Sand-Lime Products in Sea-Water: Furthermore, it was of interest to subject sand-lime products to the action of magnesium sulphate, the corroding element contained in sea-water.

Most hydraulic cements are decomposed by sea-water, either on account of too high a percentage of alumina or because they contain too much lime.

As sand-lime products contain only a trace of alumina in combination with lime, the formation of calcium sulpho-aluminate, the compound considered to be the cause of the destruction of cements in sea-water, need not be feared. On the other hand, well made sand-lime products do not contain uncombined lime, that is to say, lime in excess of the formation of mono-calcium silicate; for this reason they are not as easily decomposed as the calcium compounds in hardened cements, which contain invariably a large surplus of lime beyond the calcium silicate mentioned. A hardened sand-lime mixture, therefore, must be expected to offer greater resistance to the decomposing action

TABLE XXIX.

SAND-LIME PRODUCTS CONTAINING ADMIXTURES OF POWDERED GLASS.

Mixture of Glass and Hydrated Lime. per cent.	Sand per cent.	Initial Compression of Mixture. lbs.	Steam Pressure. lbs.	Time of Exposure to Steam. hours.	Resistance to Compression after hardening in lbs. per sq. in.			Average.
10	90	11.250	150	6	.750	.825	.862	.813
20	80	"	"	"	2.250	2.362	2.212	2.275
30	70	"	"	"	3.825	3.825	3.975	3.875
40	60	"	"	"	4.650	4.913	5.925	5.163
50	50	"	"	"	6.638	6.862	7.425	6.975
60	40	"	"	"	7.538	7.762	7.800	7.700
70	30	"	"	"	8.475	8.625	9.075	8.726
80	20	"	"	"	9.188	9.188	9.375	9.250
90	10	"	"	"	9.300	9.675	9.675	9.550

The mixture of Glass and Hydrated Lime used in these tests was composed of 80 parts by weight of Powdered Glass and 20 parts by weight of Hydrated Lime.

of the magnesium sulphate of the sea-water than any hydraulic cement.

This theory had to be verified by experiments.

A large number of blocks with sharp edges and corners, which were cut from the test cylinders, have so far been kept for three years in a solution of magnesium sulphate containing 6 grams per liter without showing the slightest trace of decomposition.

Also Mr. Feret, in the course of his experiments with hydraulic cements exposed to sea-water, found sand-lime brick that were submerged in sea-water for five years, to be perfectly intact.

If these experiments would be continued on a larger scale, with the same excellent result, there would be a large field of usefulness for sand-lime products in marine construction, either in the form of slabs, brick or even large blocks weighing many tons.

Seasoning of Sand-Lime Products: The pamphlets issued by sand-lime brick manufacturers describing the properties of their products, mention frequently that the strength of hardened sand-lime brick increases with age in the same way as lime mortar or hydraulic cements do.

In order to verify these statements, a set of tests

TABLE XXX.

MIXTURES OF HYDRATED LIME AND POWERED GLASS:

Lime per cent	Glass per cent	Initial Compression of Mixture lbs.	Steam Pressure lbs.	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs. per sq. in.				Average.
10	90	7.500	150	6	8.400	8.512	—	—	8.456
20	80	"	"	"	9.262	9.075	—	—	9.168
30	70	"	"	"	8.888	8.588	—	—	8.738
40	60	"	"	"	8.512	8.250	—	—	8.381
50	50	"	"	"	8.025	8.212	—	—	8.118
60	40	"	"	"	7.238	6.338	—	—	6.788
70	30	"	"	"	6.712	6.262	—	—	6.487
80	20	"	"	"	4.950	5.288	—	—	5.120
90	10	"	"	"	3.825	3.300	—	—	3.563
10	90	11.250	"	"	8.775	8.400	7.762	8.738	8.418
20	80	"	"	"	9.600	9.750	9.562	—	9.648
30	70	"	"	"	6.900	8.850	9.150	—	8.300
40	60	"	"	"	8.100	8.925	8.625	—	8.550
50	50	"	"	"	8.288	8.475	8.288	—	8.350
60	40	"	"	"	7.125	7.012	7.500	—	7.212
70	30	"	"	"	5.775	5.700	6.112	—	5.862
80	20	"	"	"	5.288	5.738	6.188	—	5.738
90	10	"	"	"	4.238	4.312	4.050	—	4.200
10	90	15.000	"	"	11.025	9.675	11.025	9.075	10.200
20	80	"	"	"	9.525	10.125	9.675	9.300	9.655
40	70	"	"	"	9.525	9.750	9.675	—	9.648
40	60	"	"	"	9.375	9.150	9.225	—	9.250
50	50	"	"	"	7.500	10.200	9.965	—	9.225
60	40	"	"	"	8.100	8.775	8.325	7.785	8.245

TABLE XXXI.
TESTS MADE WITH ADMIXTURES OF PUZZUOLANA (GAIZE).

Lime per cent	Sand per cent	Gaize per cent	Initial Com- pression lbs.	Steam Pressure lbs.	Time of Exposure to Steam hours	Resistance to Compression after hardening in lbs. per sq. in.				Average.
20	80	0	7.500	150	6	2.925	3.750	2.925	3.300	3.225
"	70	10	"	"	"	3.412	5.962	4.312	3.600	4.320
"	60	20	"	"	"	3.675	3.750	5.625	3.570	4.143
"	50	30	"	"	"	4.500	4.500	4.435	4.312	4.434
"	40	40	"	"	"	5.175	5.400	5.662	4.650	5.220
"	30	50	"	"	"	5.250	4.500	5.025	4.838	4.904
"	20	60	"	"	"	5.025	3.488	3.188	4.350	4.012
"	10	70	"	"	"	3.900	4.312	3.862	3.975	4.012
"	0	80	"	"	"	3.375	3.000	3.000	3.300	3.168

was made, the results of which are summed up in table XXXII.

The conditions under which these tests were made were the following:

- Pure hydrated lime.....10 per cent
- Sand90 per cent
- Initial compression.....3,750 lbs.
- Steam pressure..... 120 lbs.
- Duration of hardening process...6 hours

After having been hardened, the test pieces were kept in an atmosphere saturated with moisture.

TABLE XXXII.

EFFECT OF SEASONING ON SAND-LIME PRODUCTS.

Time after Hardening	Resistance to Compression in lbs. per sq. in.				Average.
Immediately	1.762	1.800	1.838	1.838	1.808
1 week	1.650	1.575	1.650	1.800	1.668
4 weeks	1.912	1.950	1.838	1.838	1.882
12 "	1.838	1.800	1.875	1.950	1.860
19 "	1.575	1.838	1.650	1.612	1.668
26 "	1.538	1.538	1.838	1.875	1.698

The results obtained show that the strength has not increased even after six months. However, as many manufacturers state, an increase in strength, it is not impossible that gradual drying-out of the brick in a dry atmosphere and absorption of carbonic acid cause the strength to increase in time.

Summary.

As the result of our extensive tests with sand lime mixtures we are able to state that the conditions, which have to be fulfilled in the manufacture of a reliable product, are briefly the following:

The raw materials must be silica sand and pure lime, which latter has to be hydrated completely before being mixed with the sand. The mixing must be done very carefully and the sand-lime mixture, in being moulded, must be subjected to the highest possible pressure. The time of hardening must be as long as possible, also the highest possible steam pressure should be employed.

NOVEL CONCRETE TANK WITH DOME-SHAPED BOTTOM.

The University of Arizona is located at Tucson, Ariz., but outside of the corporate limits of the city. The water required for use on the campus, including that which is used for irrigation, is supplied by a pumping plant located upon the grounds. The water which is used for irrigation is pumped directly into the ditches, supplying the various parts of the grounds, and the water which is required for other uses is pumped into an elevated tank, connected with the water mains. The tank now in use is a reinforced concrete structure 40 ft. in height and 25 ft. in diameter, with a capacity of approximately 60,000 gals. The water tank consists essentially of a vertical cylinder and two domes. The lower half of the vertical cylinder forms the tower which supports the tank proper, and the upper half of the cylinder forms the outer wall of the tank. The lower dome forms the bottom of the tank proper, and the upper dome forms the roof of the structure. A projecting band encircles the cylinder along the springing line of each dome, each band containing the steel reinforcement required to resist the adjacent dome. The thickness of the cylindrical shell is but 4 ins., and it has no buttresses to assist in carrying the load. The thickness of the lower dome is 4 ins. and of the upper dome 3 ins., except near the springing lines, where the thickness is increased.

INFRINGEMENT SUIT.

On page 12 of our August issue we carried an advertising notice of infringement suit against the McCormick Waterproof Portland Cement Company and Chas. McCormick, of St. Louis, Mo. We are informed that the suit was dismissed in the United States Circuit Court, Eastern Division, Eastern District of Missouri on July 11th, on motion of the Medusa Concrete Waterproofing Company, of Sandusky, Ohio, and a new suit commenced on July 26th, at Chicago, Illinois, in the United States Circuit Court, Northern District of Illinois, against the McCormick Waterproof Portland Cement Company, and S. T. Sjoberg, of Chicago, Ill. The name of Chas. McCormick not being a party to the last named suit.

New Address of Cement & Engineering News.
1117 Schiller Bldg., Chicago, Ill.
Tel. Randolph 934.

The Utilization of the Wastes of a Blast Furnace

By E. M. Hagar, President Universal Portland Cement Co.

Until the last decade, practically the only utilization of the wastes or by-products of a blast furnace was the use of a portion of the waste gases to raise the temperature of the incoming blast through heating the brick work in so-called hot stoves, and in some cases a small portion of the power value of the gases was obtained by burning them under boilers to generate steam for driving the blowing engines.

At the present time the calorific value of the waste gases is being utilized directly in gas engines for blowing purposes and for generation of electric power, a considerable portion of the slag is used in the manufacture of Portland cement, and the flue dust consisting of the finest ore and coke particles, is being collected and converted so as to be rechargeable into the furnaces.

The aggregate saving or profits resulting from these three developments is a matter of millions of dollars per annum, and in a modern blast furnace plant, it would almost seem that pig iron was the by-product; and, indeed, the investment in the equipment to utilize these former wastes, exceeds that of the blast furnace itself.

The writer, in his work, has come in contact with these evolutions, having in charge plants with a capacity to produce twelve million barrels of Portland cement per annum from slag and limestone, using over one million three hundred thousand tons of slag in a year, these plants being driven entirely by electric current generated by gas engines directly from the waste blast furnace gases, the power requirements being forty thousand horse power for twenty-four hours every working day. In one of the cement plants the first commercial method for reclaiming flue dust was discovered.

By using the blast furnace gases directly in combustion engines after suitable washing to remove the grit, the power obtained from a given amount of gas is equal to at least two and one-half times that obtainable by burning the gas under boilers for generating steam for use in steam engines.

A modern blast furnace of the usual size, with gas blowing engines, and gas engines driving electric generators, will provide sufficient gas to furnish seven thousand kilowatts electric power, in addition to driving its own blowing engines.

This permits the most modern steel works, such as those at Gary, Ind., to practically do away with the use of coal for power purposes, operating the rolling mills by electric power from the surplus gases.

The United States Steel Corporation, of which the Universal Portland Cement Company is a subsidiary, has already installed two hundred and fifty thousand horse power of gas blowing and gas electric units, which, it can easily be figured, displaces or saves the consumption of approximately a million tons of coal per annum as compared to the old-fashioned method.

With the modern high blast pressures, and the use of fine Missabe ore, the finest of the particles, together with the coke dust, are blown out through the top of the furnaces and are caught in the flues, dust catchers, and gas washers.

The iron ore in this dust amounts to fully three per cent of the total ore charged, which aggregates the large amount of approximately a million and a quar-

ter tons per annum in this country. Until within a few years, this dust has been thrown away or used as filling, although containing about forty per cent metallic iron.

For many years efforts were made to use this material by compressing it into briquettes, but the cost of the operation, together with the fact that the briquettes disintegrated and the dust was again blown out, led to an abandonment of the briquetting plants.

The first commercially successful method of utilizing the dust was discovered by passing the material through the cement kilns at South Chicago. Experiments showed that with the proper heat treatment, the coke dust could be burned off and the iron ore conglomerated into nodules or nuggets averaging over sixty per cent iron content. These nodules, when fed to the blast furnace, were easily and completely reduced. The fact that the sinter of the flue dust contains such a high percentage of iron and that all of the sinter is reduced, together with its physical shape assisting the steady movement of the charge downward in the blast furnace, thereby preventing so-called slips, makes the sinter more valuable per ton than any ore.

It was necessary to devise mechanical means for preventing the accumulation of the sinter on the walls of the kiln. Plants have been in operation for some years using this process, with endless chains carrying scrapers constantly passing forward through the kiln, and cooled in water on their return outside of the kiln.

Recently other methods of utilizing dust have been devised which may prove successful commercially, and the indications are that within a short time the greater portion of this former waste will be prevented.

The development of the Portland Cement industry in this country and the extension of its uses have been marvelous, and the following table shows a remarkable increase in the production of Portland cement in the United States every year since 1895, when this country first reached the production of approximately one million barrels.

Year.	Production of Portland Cement of United States, Barrels.	Production of Universal Portland Cement, Barrels.	Percentage of
			Universal to Total American Production of Portland Cement.
1895	990,324	.....	....
1896	1,543,023	.....	....
1897	2,677,775	.....	....
1898	3,692,284	.....	....
1899	5,652,266	.....	....
1900	8,482,020	32,443	.39
1901	10,711,225	164,316	1.29
1902	17,230,644	318,710	1.85
1903	22,342,973	462,930	2.08
1904	26,505,881	473,294	1.78
1905	35,264,812	1,735,343	4.92
1906	46,463,424	2,076,000	4.55
1907	48,785,390	2,129,000	4.36
1908	51,072,612	4,535,000	8.89
1909	62,508,461	5,786,000	9.27
1910	73,500,000*	7,001,500	9.52

*Government Estimate.

It may be of interest to note the increasing percentage of the total American production shown by Universal Portland cement, which is the only Portland cement manufactured in this country using slag as one of the raw materials. With the new plant now approaching completion the aggregate production of Universal Portland cement in the Chicago and Pittsburg districts will amount to over one-eighth of the country's total. Expressed in weight, the output of the finished product will be over two million gross tons per annum. Our plants in the Chicago district will consume all the available slag that is suitable for the purpose from an aggregate of nineteen blast furnaces in the South Chicago Works of the Illinois Steel Company and in the Gary Works of the Indiana Steel Company.

Comparing the pig iron production and Portland cement production of this country in figures of long tons, the percentage of Portland cement to pig iron in 1890 was six-tenths of one per cent, in 1900 ten and three-tenths per cent, and in 1910, forty-seven per cent. The continuation of any such relative growth would mean that before 1920 the tonnage of Portland cement would considerably exceed that of pig iron. I would hesitate, however, to predict that such would be the case.

Portland cement is defined by the United States government as the product obtained from the heating or calcining up to incipient fusion, of intimate mixtures, either natural or artificial, of argillaceous with calcareous substances, the calcined product to contain at least one and seven-tenths times as much of lime, by weight, as of the materials which give the lime its hydraulic properties, and to be finely pulverized after said calcination and thereafter additions or substitutions for the purpose only of regulating certain properties of technical importance to be allowable to not exceeding two per cent of the calcined product.

From this definition it will be seen that the raw material for Portland cement is not limited to any particular form of material; it may be made from any combination of materials that together furnish the proper elements. In this country Portland cement is manufactured from a number of raw materials, which, with a few exceptions, may be classed under four heads:

First—Argillaceous limestone (cement rock) and pure limestone.

Second—Clay or shale and limestone.

Third—Clay or shale and marl.

Fourth—Slag and limestone.

In all cases the raw mixture is a combination of some form of clay and some form of lime, and in the first and fourth classifications the clay materials contain some lime. This simply reduces the proportion of lime material necessary for a proper mixture.

In the manufacture of Portland cement from slag and limestone, the molten slag flowing from the furnaces is granulated by a stream of water, loaded into cars and transported to the cement plants, where it is dried in rotary driers, and receives the first grinding; it is then mixed in automatic weighing machines, with the proper proportion of ground and dried calcite limestone. These are then ground together and burnt to a hard clinker at a temperature of nearly three thousand degrees Fahrenheit in rotary kilns, using pulverized coal for fuel.

This clinker, after seasoning is crushed and ground and mixed with a small percentage of gypsum to regulate the setting time. The cement is ground to such fineness that ninety-six per cent passes through a sieve having ten thousand meshes and eighty per cent passes a sieve with forty thousand meshes to the

square inch. It is then conveyed to the stock house for storage prior to shipment.

It is necessary to use as a flux in furnaces supplying slag for cement manufacture, a pure calcite limestone. The limestone burnt with the slag must also be a pure calcite stone. It is also essential that the ores used be of a uniform and proper character.

Inasmuch as Lake Superior ores are noted for their remarkable uniformity of analysis, the resultant slag obtained from the use of these ores and a pure calcite limestone, is more uniform in its analysis than any form of natural clay deposit used in the manufacture of Portland cement and the variation in the proportions of the two raw materials used in the manufacture of Portland cement from slag is less than those of any other materials mentioned above.

In addition, the opportunity for analysis and selection of the proper ingredients through the use of an artificial material is a great advantage as compared to the necessitous use of natural materials just as they are found with their variations in analysis at different depths.

In the intense heat of the kiln, under the influence of the oxidizing flame, any sulphides in the slag are completely burned out.

The rotary kiln used ten years ago was sixty feet long and six feet in diameter. They have been gradually increased in length and diameter until the modern kiln is one hundred and forty to one hundred and fifty feet long and eight to ten feet in diameter, and there are a few even larger kilns in use. Kilns are usually set at an incline of three-quarters of an inch to the foot. With the lining and contents the modern kiln weighs one hundred and fifty tons, and in revolving upon two bearings presents interesting constructional features.

In the case of the plant at Buffington, Ind., using twenty-six thousand horse power, situated between South Chicago and Gary, Ind., electric power is supplied at twenty-two thousand volts from the steel works at these points. Each piece of machinery is driven by its individual motor, supplied with alternating current at four hundred and forty volts. The high tension line is connected through the cement plants, and the gas engines at these two steel works, fourteen miles apart operate continually in parallel. This enables the cement plant to draw its power from either source, or from both sources at the same time, as may be desirable. It has happened that one of these works has supplied power to operate the cement plant and furnished additional power at the same time to the Steel Works at the other end of the line.

The method of manufacture above described is the standard method of manufacturing Portland cement from natural deposits, and the finished product differs in no way from other Portland cements in chemical analysis, fineness, specific gravity, color, nor in the operation in practical work. It has no peculiarities whatever and has no limitations as to its application. There is no difference, from the chemist's point of view, between the manufacture of Portland cement from natural deposits, such as limestone and clay or shale, and its manufacture from limestone and slag. Slag is really a mixture of the clay from the ore with the lime content of the stone used as a flux in the furnace.

Our method of manufacture of Universal Portland cement does not embody any real invention, nor is it based on any patents. It is simply an adaptation to an artificial raw material of the regular Portland cement process formerly applied only to natural deposits.

True Portland cement in which slag is used as one

of the raw materials, should not be confused with Puzzolan or so-called "Slag Cements" which are simply mechanical mixtures of slag and slaked lime ground together without burning. Such cements are suitable only for use under ground and in moist locations.

The manufacture of Puzzolan cements in this country has practically been abandoned.

The remarkable growth of the Portland cement industry is not equalled by any other manufactured article. This is due to the economy, durability and plasticity of cement and concrete work. While large engineering work, such as dams, bridges, and heavy reinforced concrete buildings, consume large quantities of cement, the bulk of consumption at the present day is in a multitude of small uses. It takes an average shipment of only five barrels a day to take care of the average customer of a large cement company.

For example, there is a steady increase in the application of cement to new uses on the farm, such as silos, fence posts, barn floors, feeding floors, watering troughs, corn cribs, etc. There, as elsewhere, concrete is rapidly displacing all forms of wood construction, this process being hastened by the continually advancing cost of lumber.

Beautiful effects are now being obtained in concrete surface finishes and its use in decorative work is advancing rapidly.

The use of Portland cement will continue to increase until the campaign of education of the small user has reached its finality. In this direction a great work is being done to educate the general public in the proper use of cement by individual manufacturers, by the Association of American Portland Cement Manufacturers, and by the cement shows which are given in several of the largest cities every year.

In conclusion, it will be seen from the foregoing that most of the problems of utilization of wastes or by-products of the blast furnace have been solved, and that these solutions, in addition to being highly profitable, are powerful factors towards the conservation of our natural resources.

Portland cement manufactured from slag, to a large extent, replaces wood; the waste gases displace coal, and reclamation of the flue dust conserves the deposits of iron ore.

THE CEMENT SHOWS.

Concerns desiring to secure space at the next New York, Chicago and Kansas City Cement shows should remember the dates of these exhibitions as follows: New York, January 29 to February 3; Chicago, February 21 to 28, and Kansas City, March 14 to 21. Full information in regard to these shows may be had from the Cement Products Exhibition Co., 72 West Adams St., Chicago.

DESIGNING A CONCRETE CONSTRUCTION PLANT.

Sanford E. Thompson, consulting engineer, and an associate of Frederick W. Taylor in the application of scientific management to construction plants, says of the designing of a concrete plant:

"On all work of such magnitude as to make the use of a concrete machinery mixing and handling plant expedient, it is of great importance in the matter of speed and economy to have the entire plant well designed and planned out to the best advantage. And this design must of necessity vary according to the nature of the work; the way in which raw materials can be brought to the plant; the natural features of the ground where the plant is to be located; the cost of materials delivered on the job for constructing the plant; the time in which the work must be completed, the amount of money there is in the job; and any special

conditions that may exist in connection with the work. Even where the general features of the plant are practically the same for two different jobs, the details are usually more or less at variance. Therefore, it means careful and thorough study and efficient planning to effectively meet the conditions, so as to prevent waste of money and to decrease cost.

"The design of the plant for handling the raw materials for concrete and for conveying the concrete to place usually has more to do with economy in mixing than the particular type of mixing machine. As there are plenty of good mixers, engines and other machinery on the market, the particular make used, is, in a measure, a matter of personal choice, or is determined by what can be economically had at any given location, either new or bought from some previous job.

"The proposed plant should be drawn or sketched on paper, and the cost and expense of installation, as well as of operation, estimated as accurately as possible so as to determine whether the volume of concrete to be laid is sufficient to warrant the construction and operating expense. The authors have seen expensive machinery, which could not be transported readily to another job, installed on a section of work where hand-mixing would have been actually more economical because of the small total volume of concrete and its distribution over a large area.

"Usually the important points to plan for are what shall be used for handling the machinery and the concrete: whether cableways; belt conveyors; elevators of various kinds; cars hauled by dinkies; by horses or by hand on level tracks; cars hauled by cable on inclines, or derricks; whether trestles shall be built and to what extent; whether the mixers can be so located that raw material can be dumped direct to bins from standard gauge cars; whether the mixing plant shall be mounted complete on trucks or cars; or whether some special combination of a part or all these shall be used. The minimum amount of concrete that will make it advantageous to install a machinery mixing and handling plant is variable, depending on the nature of the work and local conditions to such an extent that it must be carefully figured out for each. On some jobs 500 cubic yards would be the minimum, while on others it might possibly be as high as 1,500."

SUPERIORITY OF AMERICAN CONCRETE MIXERS.

In recent visits to parts of New South Wales where dams for irrigation purposes, railways, etc., are under way, I had occasion to notice the popularity of American machines for mixing concrete. One special advantage they are said to have over machines made in England, the only other country from which they seem to be extensively imported, is in their greater convenience where small space is available and where there are natural difficulties in securing large space.

As an illustration of the local uses of concrete, I might mention the Wallarobba Tunnel, about 1,000 ft. long on a government railways line now being constructed in New South Wales. This tunnel has given considerable trouble, several serious falls having occurred recently, and it was decided to concrete it. Thousands of tons of concrete are being utilized, and a concrete mixer was imported from the United States, which turns out a truck full of concrete every minute or two. Huge molds are built outside the tunnel, hauled in on the rails, and placed in position, the concrete being then emptied between them and the wall. The molds are so constructed that the engine and trucks can run through without disturbing them in any way.

Effect of Alkali on Cement Tile

The clay tile manufacturer has advanced the theory in order to discredit cement tile and thereby sell his own goods that cement tile are so disintegrated by alkali that it is unsafe to use them. This story has been the happy thought for clay men for it has checked the use of cement tile to some extent undoubtedly. But the theory is unsupported by facts and so clearly a mere scare that it no longer has any effect in localities where cement tile have been used for a number of years. Cement tile factories are being established so rapidly, however, that the new territory opened up to their sale is large and the people therein desire to know the truth. It is for this purpose that the facts presented here are brought together.

Cement.

Cement is made from rock. The rock is quarried, taken to the mill and crushed up, put into a kiln where the temperature is about 3,000 degrees, and the klinker which forms is ground up very fine. This fine material is cement. Portland cement is required by the government regulations and the standard specifications in general use to contain certain percentages of silicates, aluminates, ferrates of calcium and other less important elements. It is Portland cement, the reliable perfect cement that is used in cement tile. Obtained direct from the cement mill as it is for the tile factory there is no material its equal as a dependable product.

Alkali Action on Cement.

Portland cement is composed of 96 per cent of silicates, aluminates, and ferrates of calcium, the remaining 4 per cent being made up of alkalies, magnesium compounds, sulphates, carbon-dioxide, titanium, phosphorous, etc. If all the elements making up the 4 per cent were destroyed by alkali action the loss of strength of the cement would scarcely be detectable by the most precise means of testing, hence we need only to consider the effect on those materials composing the 96 per cent leaving a discussion of the minor elements to a longer and less practical discussion at some other time.

The tile manufacturer mixes in certain proportions the cement and sand, and to the mass adds water in sufficient amount to change the silicates, aluminates and ferrates of calcium to hydrates. The hydrates are in the form of crystals and colloids and when the hydrating process is completed we have a material which is practically insoluble in alkalies or acids. We grant that there is a certain amount of soluble lime in concrete, and that there is a very limited amount of other elements which are slightly soluble. What is the result? Suppose that rain water, alkalies, or acids in the soil should dissolve some of these materials to the extent to which they are soluble, the carbon dioxide in the water precipitates the lime as carbonate, a material which is deposited in the pores of the concrete filling them up and arresting further chemical action. It is this fact that makes concrete more and more dense as the years go, resisting, disintegrating action of every kind more and more perfectly. Statements therefore that cement tile will be disintegrated by alkali, acids, etc., are not founded on fact.

In the laboratory very strong concentrated alkalis and acids can be had. In the use of such liquids it is possible for a demonstration to be made showing that almost all materials are soluble. Iron, wood, cement, clay—oh, yes, clay—in fact almost all materials can be dissolved by strong laboratory acids and alkalis.

Where acids or alkalis are present in the soil to such an extent that crops cannot be raised at all the use of any kind of tile may be a risk, although in the case of cement tile as explained above, the precipitation of the carbonate in the pores will arrest serious action so that the soil will be purified and the tile will do its further duty for all time to come. It must be borne in mind that for such service only the best tile should be used, if clay, then dense, hard burned, preferably glazed tile, free from laminations (as though made up of sheet upon sheet of material), free from limestone pebbles and from dirt or other poor material in the clay; if cement, then dense, firm tile made according to standard specifications.

In the ordinary case where tile are used there is nothing in the contention that there is anything in the soil harmful to drain tile and instances of originally good cement tile failure from the effect of alkalis or acids cannot be found in practise. Thousands of miles, yes tens of thousands of miles, of these tile are in the ground in Iowa, Indiana, Ohio, Michigan, Minnesota, Colorado, New Mexico, Mississippi, Florida, New York and Canada. Some cement drain tile have been in the ground as long as thirty-nine years, some carrying the alkaline waters from factories; some cement sewer tile have been carrying strong acids from paper mills for sixty years, and no failure of any Portland cement tile from alkali or acid effects can be found. Even in the cases where natural cement was used, where the tile were made by hand, where the result was known to be an inferior grade of tile, the instances of any effect are few indeed.

The clay people talk of the effect of alkali on cement and then in another breath advocate the use of cement mortar for brick sewers, a place where cement has given such a satisfactory account of itself that it is universally specified today.

It is impossible for us to conceive of the Government using cement to the extent of 4,000,000 barrels in the Panama Canal where it is exposed to the alkali of the sea water, of its use in the vast irrigation projects of the West, in bridges, buildings, tunnels, sewers, mines, railroad construction, etc., if it were true that cement would not stand a satisfactory test. It would have been impossible for five million dollars worth of cement tile to have been sold in this country and Canada last year if there were any truth in the scare started by the clay interest for their own ends.

REINFORCED CONCRETE BINS.

The new reinforced concrete bins of J. B. Speed & Co., at Speeds, Ind., have been completed by H. H. Snyder, of Louisville. The bins are four in number, cylindrical in shape, and have an inside diameter of 36 feet. They are 50 feet high, and owing to their economical design are expected to be used more freely hereafter by cement companies. Speed's cement, Carnegie bars and Ohio river sand were used in the construction, some of which was done in cold weather, necessitating the burning of fires for the protection of the concrete. A feature of the bins is that the cement will be conveyed to the openings in the roofs by means of machinery, being let down into the bins, whence it may be withdrawn through vents in the bottom. Cars can be run under the bins on tracks in tunnels provided for the purpose, gravity performing the work of loading the cars. Plans were drawn for the bins by the cement company, assisted by W. H. Gazlay, of the National Concrete Construction Company, of Louisville.

Proposed Standard Methods of Testing Drain Tile

By C. M. Powell, Chicago, Ill.

The subject, "Proposed Standard Methods of Testing Drain Tile," takes for granted two things: First, that drain tile should be tested; second, there should be but one general accepted method of making such tests. It can hardly be assumed that everyone recognizes the importance of the former or realizes what the latter would mean to the cement drain tile industry. All kinds of steel, cast iron, wrought iron, cement, lumber, paving brick and all structural materials are purchased on specifications. The interest shown at present on the subject of tests for drain tile indicates that in the course of a short time this product can also be included in the above list.

According to the best available information there were made last year in this country some 124,000,000 cement tile, 12-inch and less in size, valued at approximately \$4,000,000. Certainly the expenditure of this sum annually justifies the user in insisting upon some guarantee of a satisfactory quality.

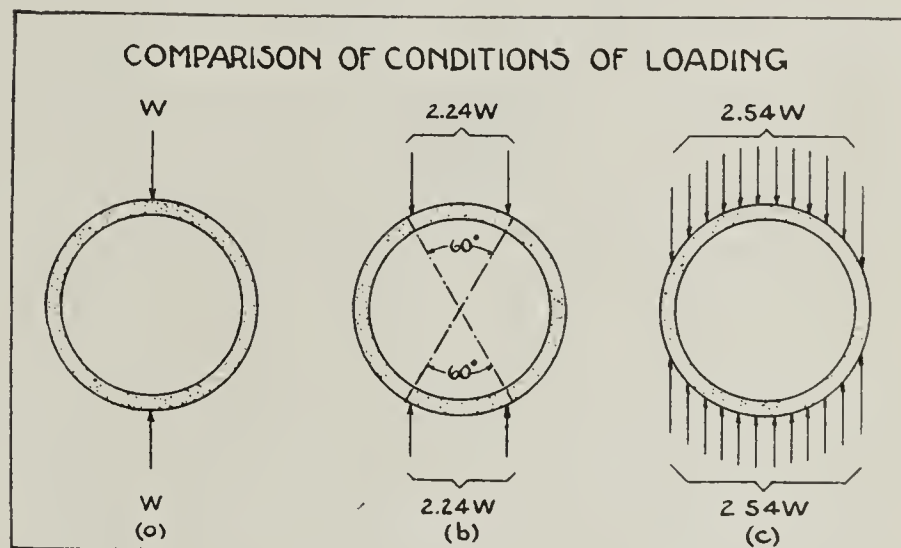
The general practice of purchasing cement drain tile on a specification would benefit the manufacturer who turns out a first-class product and free him from the unjust reflection which the inferior product of the unscrupulous or unqualified manufacturer throws upon his business. It would relieve the drainage engineer of a lot of responsibility, because the quality of the tile would not be left to his judgment, but would be a matter of satisfying certain definite requirements. A set standard of quality for cement drain tile would reduce the failures to a minimum and leave nothing upon which the other tile interests could base their claim that cement tile is not adapted for drainage purposes.

It was the writer's privilege recently to attend the twenty-fifth annual meeting of the Illinois Society of Engineers and Surveyors. This society has probably done more on drainage in its twenty-five year's existence than any other society in the country. Cement tile was a live topic at this meeting. One drainage engineer present, who had at that time twenty-nine drainage districts under his direct supervision, expressed the consensus of opinion when he said he was not using cement tile in any of his work because he could not be assured that the tile had been well made with sufficient cement, suitable aggregate and properly cured. Until the engineers have this assurance cement tile will not receive their entire confidence or enjoy the reputation to which the merits of a good quality entitle the product. This assurance can be guaranteed not only to the engineer, but to everyone concerned, if you, as manufacturers, sell your product on a specification. When this is done the drainage engineers will be boosters, the claims of other tile interests will be discredited, all will recognize the merits of cement drain tile, your product will continue to be used and its further introduction made possible.

A specification for drain tile which will bring about these things must necessarily be one which represents a harmonization of the views of manufacturers, engineers, societies, engineering colleges and experiment stations regarding what requirements will give the desired quality of product. This is the means whereby the non-essentials will be rejected and only the fundamentals retained. Such a specification can be prepared only after the most painstaking investigation,

thorough study and serious consideration. All this work will be justified by the result, which could be accepted by all concerned as meeting every possible contingency, a true standard in every sense of the word and the best that could be drawn up. The process of manufacture and the conditions in most, if not in all, factories are such that tile cannot be manufactured to comply with more than one specification except at an increased cost of production. On the other hand, making all tile according to requirements, worked out as suggested, would make for a standardization with a tendency to reduce the cost or increase the output, which amounts to the same thing.

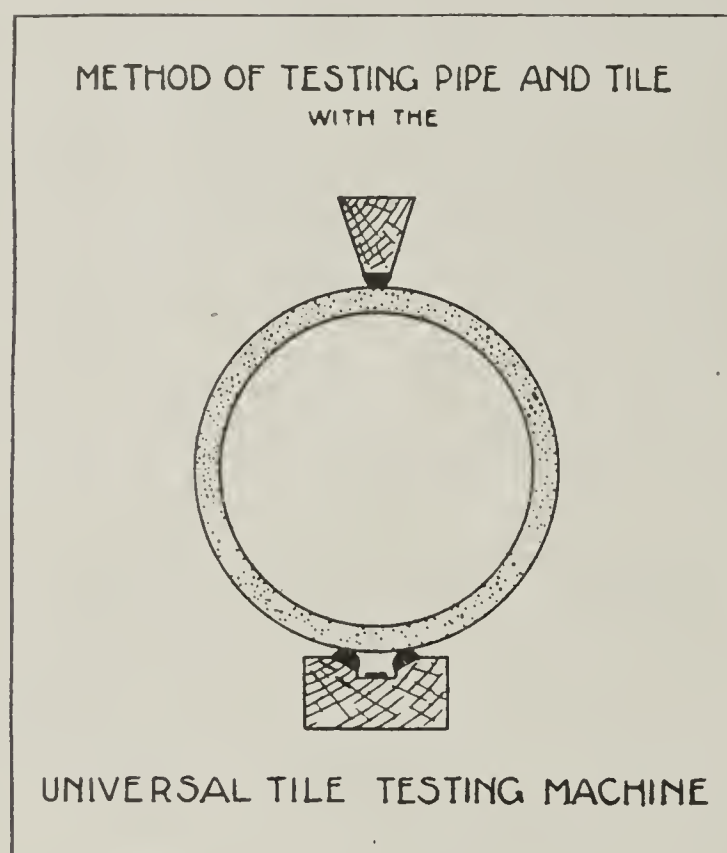
The American Society for Testing Materials, as you know, has prepared specifications for structural materials in general that are the accepted standards throughout the country. Last summer Mr. C. W. Boynton, inspection engineer, Universal Portland Cement Co., brought to the attention of this city the need of standard tests and specifications for drain tile, and their executive committee has recently authorized the creation of a special committee to study thoroughly the drain tile question and report standard tests and specifications for drain tile, and their executive committee to study thoroughly the drain tile question and report standard tests and specifications at its earliest convenience. This committee is



now being appointed and as soon as completed the matter will receive its immediate attention. As is the practice of the American Society for Testing Materials, the co-operation of other societies and associations will be sought. The Illinois Society of Engineers and Surveyors at its last meeting in East St. Louis, January 25-27, 1911, authorized the appointment of a committee on standard tests and specifications for drain tile to co-operate with the committee of the American Society. In due time no doubt the committee appointed by the American Society will invite the co-operation of the Interstate Cement Tile Manufacturers' Association in this matter. What the American Society for Testing Materials recommend in this matter will have great weight, and a uniform specification will result by the adoption of these recommendations by all other societies. If each local society and college or experiment station makes tests and issues recommendations regarding proper requirements for drain tile, there would be no uniformity and this would

lead to endless confusion and disputes between manufacturers, engineers and purchasers. For instance, if such specifications are adopted in Iowa the drain tile you furnish for use in that state would have to meet these requirements, while those which you furnish for use in Minnesota would probably have to meet some other requirements.

Considering what a standard specification for drain tile should embody, the first attention must necessarily be given to a specification governing the tests of tile. Since this material is used under conditions which subject it to external earth pressure that sometimes cause failure, a breaking test by the application of an external load suggests itself. The pressure may be applied in a variety of ways. The load which a tile or pipe will stand without breaking depends upon the conditions of loading. The comparison of the stresses produced by the assumed loadings illustrated in the drawing shows that under the concen-



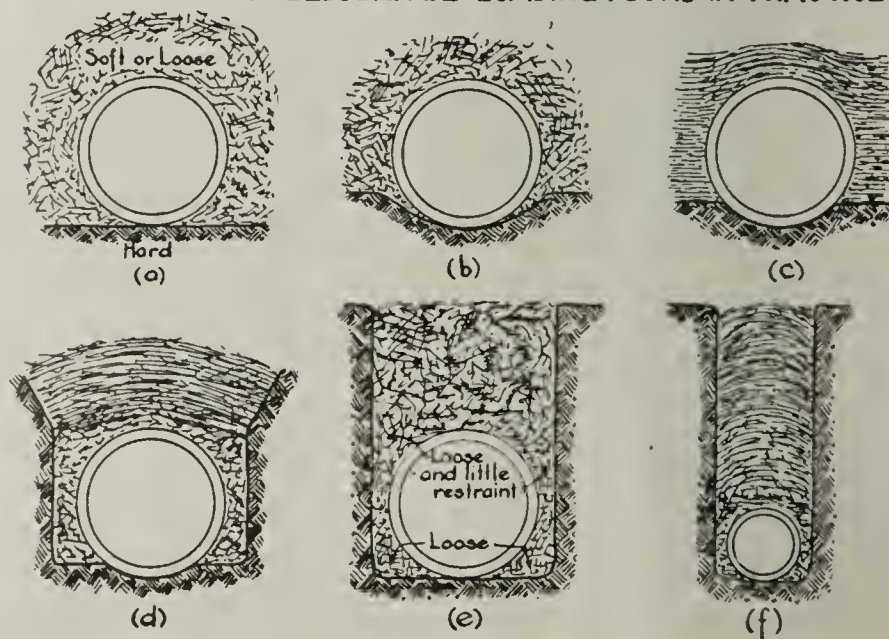
trated loading, Fig. (a), the pipe will sustain the smallest load. Under the loading in Fig. (b) a load two and one-quarter times as great as if it were concentrated at one point top and bottom will be required to cause failure. If the load is uniformly distributed across the horizontal projection, as shown in Fig. (c), over two and one-half times the concentrated load will be required to break the pipe. It is therefore evident that tests of tile to be comparable must necessarily be made under the same conditions of loading, and this is why first attention must be given to the methods of making the tests.

Before taking up which method is best adapted for the purpose, let us look into the conditions of loading which may be found in practice. The amount of the load and its distribution, and therefore the stress in the tile, depends upon a number of conditions; the nature of the earth used in the filling, the method of bedding the pipe, the way of tamping the earth at the sides, the amount of lateral restraint or pressure of the earth horizontally, the method of filling and packing the earth above, the conditions of moisture in the earth, etc., all have an effect upon the amount of external pressure on the tile. Professor Talbot, in University of Illinois Engineering Experiment Station Bulletin No. 22, calls attention to the following ditch

conditions: If the layer of earth immediately under the pipe is hard or uneven, or if the bedding of the pipe at either side with soft material is not well tamped, as indicated in Fig. (a), the main bearing of the pipe may be along an element at the bottom and the result is in effect concentrated loading, hence the tendency of the pipe to fail is greatly increased. In bedding the pipe in hard ground it is much better to form a trench so that the pipe will surely be free along the bottom element even after settlement occurs, and so that the bearing pressures may tend to concentrate at points, say, under the third points of the horizontal diameter (or even the outer $\frac{1}{4}$ points). This will reduce the tendency of the pipe to fail, as shown in Fig. (b) on the last slide.

In case the pipe is bedded in loose material the effect of the settlement will be to compress the earth immediately under the bottom of the pipe more completely than will be the effect at one side, as indicated in Fig. (b), with the result that the pressure will not be uniformly distributed horizontally. Similarly in a trench if loose material is left at the sides and the material at the extremities of the horizontal diameter is loose, and there is little restraint, as indicated in Fig. (e), the pressure on the earth will not be distributed horizontally and the amount of stress in the pipe will be materially different from that where careful bedding and tamping give an even distribution of bearing pressure over the bottom of the tile. In case of a small tile in a deep trench the load upon it will be materially less than the weight of the earth above, as shown in Fig. (f), where the earth forms a hard, compact mass and is held by pressure and friction against the sides of the trench. If the large tile is held in a trench with sloping sides, as shown in Fig. (d), the load which comes upon the pipe will be materially less than the earth immediately above it. Should the sides of a deep trench cave, the pressure against the pipe will differ occasionally from that which obtains in the case of an earth filling as shown in Fig. (c). Your own experience will probably suggest other conditions of loading which might occur in the ditch. The ones described are sufficient, I think, to indicate that a wide variation exists in the amount of pressure which will come upon a tile in actual practice. It is not practical to attempt to select any one of these conditions as being representative. If one were to be on the safe side a condition which produces in effect that of a concentrated loading must necessarily be selected. However, from experience in the field, at the tile plants and in the laboratory, we have found that the conditions of loading found in the ditch are not as important to consider in selecting a

CONDITIONS OF BEDDING AND LOADING FOUND IN PRACTICE



method of loading for making the tests as are the conditions under which the tests must be made. The latter govern the selection of the method best adapted for these tests. For instance, take the standard strength test for cement: This test is made in tension, not because it approximates in the least degree the conditions under which the material is used, but because it is a simple test and one which gives the engineer and cement manufacturer a fair knowledge of the material and guides him in the use of it.

Let us consider for a moment the purpose of the breaking test, where it will be made and by whom it will be made, in order that we may get a clear idea of the requirements of a practical tile testing machine that can come into general use. The purpose of the tests is to determine under what load a tile will break and in this way to furnish a basis for comparing the quality of a tile from one plant with tile from another plant. The tests will be made at the plant where conditions are seldom favorable for doing such work scientifically, and out along the line of the ditches where the engineer will haul the testing outfit onto the job, set up and make a few tests and under the least favorable conditions. The operators will not as a rule be familiar with such work and cannot appreciate the necessity of numerous details, or may be careless and neglect them should such details of operation be required. These conditions demand of the testing machine, first; that it must be accurate to give comparable results; second, it must be capable of rapid operation to save the superintendent's time and the engineer's time, and therefore the user money; third, it must be simple, and for lack of a better expression, absolutely "fool-proof." The operations required to make a test must be reduced to the fewest possible number. Can a machine be devised which will meet these essential requirements and duplicate ditch conditions?

At the start the various methods which had been used up to that time were considered. The method of loading, shown in the figure, is the one used at present in the Universal machine and one which we have found can be safely used on 1,000-pound capacity platform scale for tile up to 30-inch. The distance between the lower supports is fixed at 2-inch, and while the bending moment developed is not exactly the same for the different sizes there is practically no difference above the 6-inch size between it and the one point of support. The amount of load required for each size to sustain under this condition of loading will take care of the little variation in the stress developed in different sized tile by this loading. Analysis of this loading shows that theoretically there is but 5 per cent difference on a 4-inch tile, $2\frac{1}{2}$ per cent on the 6-inch size, less than one-third of one per cent on the 12-inch size and no difference on 24-inch tile. As in testing, the results will be reported in, say, pounds of load per foot of length for a given diameter and not as a breaking load of so many pounds per square inch of wall section; that is, modulus of rupture, the small difference in this load for the smaller sizes will not be at all objectionable. For the 12-inch size it is only three pounds in one thousand; for the larger sizes it is too small to figure. This loading is scientific because it can be accurately calculated and the results agree closely with the tests. It is also practical. What more could be required? Comparisons will not be made between a certain make of 4-inch tile and some other make of, say, 12-inch tile. What is required is a method so accurate, simple and absolutely controllable in any operator's hands that the results of tests on, say, 8-inch tile made along the ditch by the engineer or his assistant are compar-

able with the results that you or one of your men will get at your plant on tile of the same size, other things, such as age, mixture, etc., being the same. If a tile testing machine is so constructed that the results obtained may be juggled by the operator, intentionally or not, imagine the field for dispute which is immediately in store for the manufacture and inspector who passes on the product.

A specification for tests of tile should not be such as to require any computations or calculations on the part of the man making the test, because it can be put in a form so that this is not necessary. Calculations are all right for research work, but the average tile manufacturer or drainage engineer will not stand for any unnecessary work in this respect and a good specification will not burden him with it. It should not be compulsory to figure the breaking load per square inch of wall section; that is section modulus. The breaking load can be such as will require a good quality of concrete and this will take care of the section modulus.

There is one other important detail closely connected with a method of testing which must be considered and that is the application of the load to the specimen. This is one of the fundamental principles of testing which has been long recognized and always specified in making such tests as the one in question. As a case in point I quote from "Uniform Methods of Testing Portland Cement" regarding the strength test as follows:

"The load should not be applied too suddenly, as it may produce vibration, the shock from which often breaks the briquette before the ultimate strength is reached. * * * The load should be applied at the rate of 600 pounds per minute."

In the design of this machine simplicity, speed, ease of operation and accuracy of results have been kept constantly in mind. The machine will cost as little to build as is consistent with these essentials. The machine itself is the best proof that we have realized the importance of these essential requirements better than others have. This is to be expected since we have used the machine for over a year in tile plants and on the line of the ditch in three different states, thereby becoming acquainted with just what is required.

We have without doubt made as many tests on drain tile in our investigation of this subject during the last few years as any one. I am glad to have the opportunity to present some of the things we have learned concerning the proper methods for testing tile and also to point out the merits of the machine we have designed to make these tests. The purpose in so doing is not to ask you as an association to adopt as your standard the methods we recommend as being the best which can be followed for making these tests, although you could not at this time adopt a better one. But with the best interest of the cement tile industry at heart, we believe that at present nothing of this kind should be adopted. Furthermore, without a better understanding of this important subject than it is possible for you to get from the descriptions of the several proposed methods, as presented, you are not qualified to pass judgment.

GLAZED CEMENT PIPE.

The Pacific Glazed Cement Pipe Machine company, C. F. Allen, president and manager, is busy manufacturing machines for the trade. These machines are now in operation at Portland, Aberdeen, Tacoma and Bellingham, covering the territory west of the Cascades. Other plants are projected.

Modern Transportation Methods in the Concrete Industry

By G. T. Blackiston, Pittsburgh, Pa.

One of the principal factors of present day economy in concrete products plants is introduced in the conveyance of the product, and the materials used in its manufacture, from place to place in the plant, and to and from the shipping car.

Under former methods barrows or wagons were utilized to transport sand, gravel and cement, through the plant. Both of these methods were slow and soon gave way to definite improvements. Different methods were tried, including narrow gauge trackage and wooden cars. The latter system proved to be the more practical and economical, but it had many dis-

necting permanent branches to other parts of the plant. In addition, laterals were run from the main track to the working places. As the excavation proceeded, additional sections could be added by taking up the sections already laid and transferring them closer to the seat of operations. The track was light enough to be shifted from side to side, as it needed no ballasting.

One or two cars could be filled on each side of these laterals and when ready to be sent to the plant could be coupled into trains on the main track, and either pushed by laborers or pulled by mules or horses. Two



Universal Mines of the Bunsen Coal Co.—General View.
Clinton, Ind.

Roberts & Schaefer Co., Chicago, Consulting Engineers.

advantages which seemed insurmountable. The cars could only be run to certain points, as the track was permanent. The base of operations such as the point of supply of the various materials, constantly changed, leaving gaps between the end of the track and the working places, across which the material had to be transported in barrows by laborers.

About this time, the Orenstein-Arthur Koppel Company, Pittsburg, Pa., perfected a system of portable narrow-gauge sectional track. The track was made of small, light rails and steel cross ties. It was put out in 15-foot sections, a cross tie supporting the rails at each end. By means of special inter-locking ends these sections could be quickly connected without having to waste time in tightening rail joints or spiking tracks to ties.

Concrete men were among the first to take up this mode of transportation. It afforded an efficient, economical and thoroughly effective system of transporting material and finished product within the plant, and also from the base of excavation for sand and gravel. One track was, in the majority of cases, laid through the plant in order to connect the various departments with the shipping point, turntables and switches con-

men could lay a complete railway system in a few hours after the switches were located, as the general plan of the system is laid out on paper at the car factory.

Where wooden cars were formerly used, the Koppel Company introduced steel dump cars. They were found to be more durable, out-lasting the wooden type many times. To their design as much attention was given as to modern railway cars. Many improvements in efficiency were inaugurated. Roller bearings were used on the journals, thus making it possible to propel two steel cars as easily and quickly as one wooden car had been moved. Being of steel they are far more rigid than wood, and, although the improved steel cars cost a little more, they are far cheaper in the end, as little or no up-keep is necessary, and they are not affected by the heavy weight of the load, being scientifically designed to sustain the heavy loads they are intended to haul.

When the enormous economy in labor is considered, this system of cars and portable trackage has aided materially in the wonderful progress and development of the concrete industry. Where the system is under constant strain, it is poor economy to equip a plant with anything but the very best obtainable.

Modern Coal Mining Plant of Concrete Construction

Five miles southwest of Clinton, Ind., on the C. & E. I. railroad are the Universal mines of the Bunsen Coal Co. Its construction typifies the best modern practice, and consists of fireproof and permanent structures only, thus eliminating those features of the usual design which might result in loss of life and cessation of work.

A combined plant to operate on two seams of coal was planned to avoid duplication of machinery and buildings. There are two main hoisting shafts, one ending in the upper seam and the other passing through the upper to the lower seam. One air shaft cares for air supply to both mines. It is divided into two air compartments and two manways, one set ending in each seam.

The plant above ground is built entirely of reinforced concrete, not only for foundations but for walls and roofs, the latter of which are of concrete tile laid directly on steel purlins. The tipples, however, and the roof supports of all the buildings, are of structural

every part of the structure is thoroughly fireproof and as nearly permanent as the available materials allow.

The smokestack is 10 feet in diameter on the inside and will be 175 feet high. The vertical reinforcing rods are shown above the steel forms and the scaffolding required for workmen and hoisting materials is also shown. A lining of fire brick is carried up to a point 50 feet above the smoke flues and an air space is left between the lining and the concrete for its better protection.

The boiler house interior illustrates an excellent use of reinforced concrete for coal bunkers. Coal is received and stored immediately above the boilers and coal will be chuted directly from these bins to the traveling grate hoppers. It will be noticed that all the framing, the supporting columns, struts and braces are of concrete. It will also be noticed that the bins were carried high enough so that light from the windows can pass beneath them and properly light the boiler room, a point often over-



Power House—Concrete Tile Roof.
Bunsen Coal Co.'s Mines.

steel. The illustrations following will give an idea of the success which has been obtained in the carrying out of this plan.

The combined plant consists of boiler and power plants, shops, storehouse, miners' bathhouse, ventilating plant, granary, stable and office, common to both mines, and two steel tipples and reinforced concrete hoisting plants for the two shafts. The accompanying cut shows a general view of the plant: The two steel tipples are under construction and the hoisting plants are shown one on the right and the other on the left, just behind the boiler plant and smokestack which are in the foreground. Other buildings appearing are the water purifying plant, the power plant and the miners' bathhouse.

The boiler plant and the concrete smokestack are shown below. This structure is typical of all the plant buildings. The foundations, walls, pilasters, copings and window sills are of reinforced concrete and the roof is of concrete tile. The floors are also of concrete and the window sash of steel. The only wood used is for the doors and the door frames. Thus,

looked in boiler room design. Throughout the length of the boiler house and below grade there is a concrete-lined tunnel in which cars receive the ashes directly from the hoppers beneath the grates. There is no hand labor required in handling either coal or ashes.

The general appearance of all the structures of the plant except the office, is similar to that of the power house. The cement roofing tile is well illustrated in this view. The method of lapping tiles on the sides and on the ends and the method of finishing the roofing at the end of the building is well shown where the three tiles are omitted.

There is a general tendency on the part of the better class of mining companies to go beyond the mere letter of the law in providing wash houses for the men. Experience has taught that there is really small benefit to the miner in appearance or comfort, when he is simply provided with a wash basin and water. A commendable spirit has been shown on the part of the miners to make use of the excellent and modern facilities for bathing that have been installed at this plant. The building is 32x62 feet in size, is of

reinforced concrete, with concrete floors and tile roof. Excellent ventilation is allowed by ample vents in the roof. Substantial wooden benches, shower baths and basins are furnished and the interior construction is such that a hose may be turned on the entire interior and the water can quickly drain to the sewer outlet at one corner. This makes it possible for an attendant to keep the building in a clean and presentable condition at all times.

Another feature of the plant is the office building 34 x 40 feet, of cement blocks, with slate roof and a large porch for the comfort and convenience of the superintendent, engineers and the general office force. It is an excellent structure and of substantial appearance.

All of the mine shafts are lined with concrete instead of the usual timbering. The last illustration shows the top section of the concrete air shafts and manways. This has four separate compartments, one airway and one manway for each mine. It is hard to understand why mining companies have been so tardy

specification of concrete for shafts would go a long way toward eliminating one of the greatest dangers, the wrecking of a shaft and the entombing of workmen far below.

The plant has been built according to the design of Roberts & Schaefer Co., of Chicago, and the entire work has been superintended by them.

Mr. Clay F. Lynch is the general superintendent and Mr. A. F. Allard is the construction engineer for the owners.

Universal Portland Cement was exclusively used in both overhead and shaft construction.

MIXING CONCRETE FOR STREET PAVING.

To mix and place concrete economically for street foundations it is necessary to have a specially designed mixer. The object is to handle materials with as few hand operations as possible. The machine must not be too expensive in first cost or operation. To get the most benefit from the cement used a batch mixer



Boiler House Interior—Concrete Coal Bunkers and Structural Members.
Bunsen Coal Co.'s Mines.

in adopting concrete for shaft linings, when its superiority is so evident. In no construction is its advantage so clearly demonstrated as in this class of work. When a building of wood is wholly or partially destroyed by fire, the loss is ordinarily confined to the building destroyed, while the burning of a wooden mine shaft may often destroy a mining property worth many times the value of the shaft itself. Again, the lining of a shaft with a material subject to decay makes constant renewals necessary. When partially decayed such a lining may cause a cave-in and endanger lives. This is hardly justifiable when a material no more expensive than concrete will make the shaft absolutely permanent and also fireproof. We believe that the advantages of concrete construction for mine shafts will be so apparent, when those mines that have already been lined have been studied by engineers and owners connected with this class of work, that concrete will come into general use for this purpose. Several states have passed laws, making it necessary to make certain parts of mine construction so fireproof that accidents such as are continually happening throughout the coal region, cannot recur. The

is necessary, and is specified by city engineers who want the best results.

We have used for one season a Koehring street paving mixer which has a distributing drum on discharge end. It has laid about 20,000 street yards of 6-inch concrete during the last season without need of repairs. The same is equipped with an 8 horse power engine and 10 horse power boiler and the regular No. 14 Koehring mixer drum and automatic water tank, all of which are mounted in a heavy truck, the wheels of which have wide tread to protect the subgrade.

On each side of the boiler is a runway for the charging skips. There are two charging skips, each holding more than half the entire batch, which enables the charge to be loaded twice as fast as if only one skip were used, and also gives even keel to the machine. While the skips are up discharging into the mixer drum, the wheelers load their barrows and are ready to load skips as soon as they are lowered, thus working steadily and gaining time.

The skips empty into chute to mixer drum. The water is applied to the same for each batch from the automatic water tank, and as the mixing is very rapid,

the batch is discharged to the distributing drum after about one-half turn of the mixing drum.

The distributing drum is 18 inches in diameter and 15 feet 9 inches long and has blades riveted spirally on the inside. The same is supported by two roller



Reinforced Concrete Boiler House and Stack.
Bunsen Coal Co.'s Mines.

chains from a gantry and swings in an arc of 180 degrees. One chain is an idler, but the other drives the drum at slow speed through the chain of gears from engine shaft. The spiral blades continue the mixing operation and also pass the concrete rapidly to the dis-

face, this being considered the best consistency for good concrete.

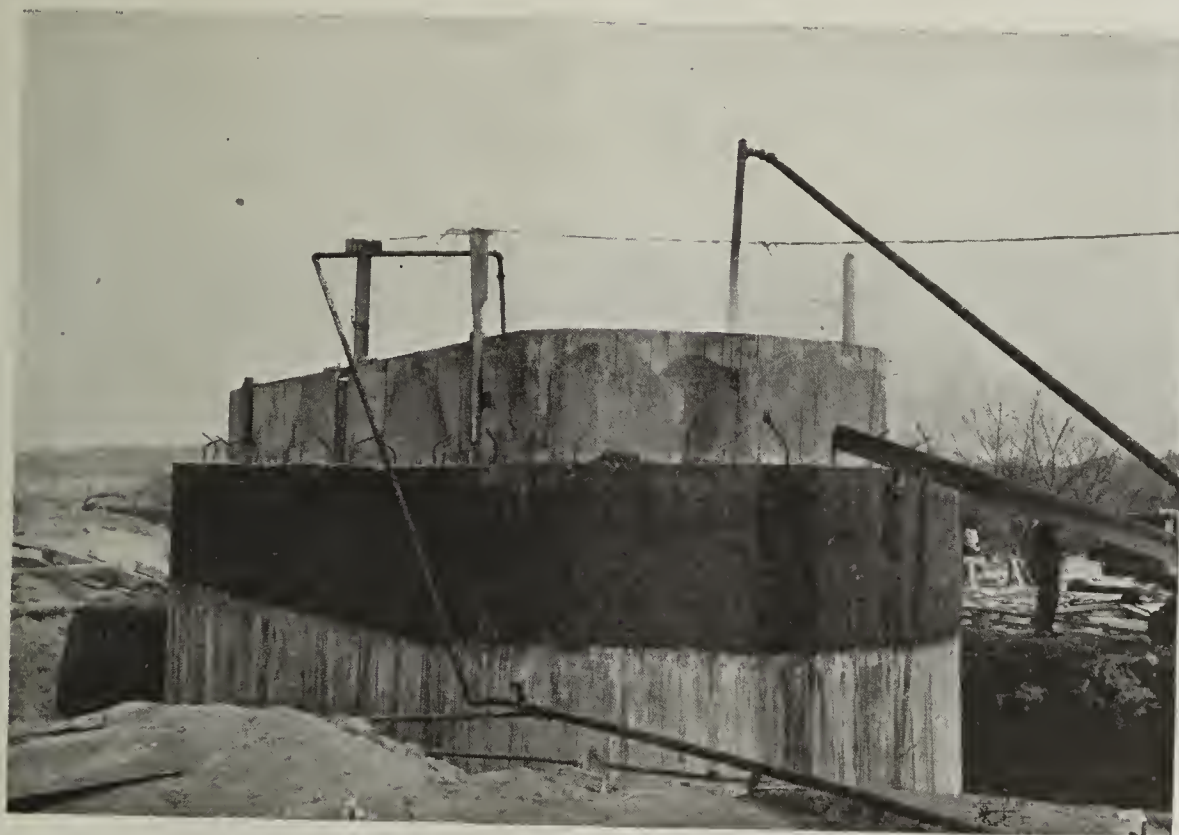
As the work progresses the machine is moved forward with its own traction and thus is a self-contained plant. It saves all wheeling of mixed concrete, and when the unmixed material is distributed carefully this wheel may be also kept down to the minimum. The use of wheelbarrows has been successful on the charging end for the reason that the men are loading barrows while skips are up. This saves time, as a barrow dumps into the skip practically as quick as a man can throw a scoopful, and the difference in quantity is immediately seen to be a saving in time. Also where an occasional longer wheel comes on account of scarce quantity of material, there is no delay.

This machine laid the 6-inch concrete base in New Jersey street a total of 6,400 street yards. The total labor cost, including all delays, man in charge receiving material before work started, coal, etc., averaged 4 $\frac{7}{8}$ cents per yard. We used 12 men as follows:

One foreman, per day.....	\$5.00
One engineer, per day.....	5.00
Two men, smoothing and leveling concrete, each, per day	2.00
One man, discharging from mixer, per day.....	2.00
One man, cement, per day.....	2.00
Five men, loading skips, each per day.....	2.00
One man, cleaning grade, per day.....	2.00

With these men, as above, it was easy to maintain an average of 1,000 yards per day of ten hours. Many days as much as 1,200 yards were laid, proving the assertion that it is only the ability to get material into the charging skips that governs the capacity of the machine. For instance, one day, or rather part of a day, 780 yards were laid in six hours, or at the rate of 1,300 yards in ten hours.

On the average basis of 1,000 yards per ten hours



Concrete Lined Air Shafts and Manways.
Bunsen Coal Co.'s Mines.

tributing end, where it is deposited where desired, by swinging the drum from side to side. Thus the material is handled by the machine from skip to final location in the street foundation. The concrete is run through wet enough so that when leveling and smoothing with shovels the grout comes to the sur-

with the men as stated, the labor amounts to \$30.00, to which add \$2.00 for coal and oil, gives a total of \$32.00, or at the rate of 3.2 cents per yard. After using this machine for one season we are highly pleased with the same.—The Marion County Construction Co. By W. L. Smith, Indianapolis, Ind.

New Portland Cement Plant at Norfolk, Virginia

Realizing that the South offers almost unlimited opportunity for the development of concrete construction, that her railway enterprises, mills, warehouses and factories already require large quantities of cement, that her manufacturers and engineers are wisely adopting this most durable and fireproof type of construction, and that carrying charges have become a most important factor in the cement industry, the American Cement Company, to take advantage of this promising field and to enjoy exceptional shipping facilities by land and water has, through a subsidiary corporation, the Norfolk Portland Cement Corporation, established a million-dollar cement works near

has the market, the shipping facilities, and the raw product. Hard dry shell marl and clay are used at the Norfolk plant.

The following description of the plant and methods of manufacturing are taken from an article by William H. Stone in the *Manufacturers' Record*, of Baltimore:

The deposits of marl, or what is known as "hominny marl" locally, which is used by the company, are located on branches of the James River near Smithfield and Chuckatuck, Va., and about twenty miles from the cement plant. These marl deposits were formed in ages past, and they are very high in the



Steel Construction in the Erection of the New Plant of the Norfolk Portland Cement Corporation.

Norfolk, Va. The term "million-dollar plant" is used advisedly, for it at once conveys to those at all familiar with the manufacture of cement the importance and magnitude of the enterprise. Cement mills that are actually built are costly affairs and to be operated with success require far more capital, business acumen and attention than one un-informed on the subject would imagine, especially if he has encountered a prospectus from that class of promoters who are promising from 60 to 80 per cent clear profit on

properties desired for the manufacture of Portland cement.

The company controls nearly 4,000 acres of land, extending some miles along creeks and ravines, all of which contain large quantities of marl clay. The removing of the marl from its deposits is a very simple and economical proposition. No blasting is necessary, the entire work being done by steam shovels. The material is loaded directly on cars running on a railroad line built by the company extending from the



View of a Marl Bed from Which Portland Cement Will Be Made.

every barrel manufactured. There is, however, as stated, a splendid opportunity in the south for further development of the cement industry under proper conditions. An essential condition is that the mill should be sufficiently near the consumer to escape the heavy carrying charges that, for example, confront the mills of the congested Lehigh district in attempting to supply southern demand. A matter of equal importance is that the cement manufactured should be a true Portland cement of the highest quality, and not an experimental product. The location selected

marl and clay deposits to a pier which has been constructed for loading the raw material on barges, by which means it will be conveyed to the plant at Norfolk. These barges will have a capacity of 500 tons each. Upon arrival at the plant at Norfolk, which is located directly on the southern branch of the Elizabeth River and opposite the United States navy yard, the barges will be unloaded with large buckets having a capacity of 100 tons per hour and operated by two hoisting engines made by the S. Flory Manufacturing Co., Bangor, Pa.

The raw materials will be dumped into bins at the pier, the one for marl having a capacity of 500 tons and the one for clay a capacity of 100 tons. From these bins the materials will be carried on belt conveyors over head to a storage building 92 ft. by 100 ft., having a capacity of 10,000 tons of marl and clay combined.

Under the storage warehouse are four reinforced concrete tunnels, three for marl and one for clay. In these tunnels are belt conveyors, on which the raw material is fed from the bins and carried to a pit,

ing through these rolls the material is brought by bucket conveyors to large steel bins, which feed into thirty grinding machines. From these the material is passed by means of screw conveyors to a large pit and elevated by bucket conveyors to the top of the building, and is then carried over the engine room by belt conveyors.

This method of conveying material over the engine room is one of the unique and interesting features of the plant, as it eliminates a great deal of waste space. After passing over the engine room the ma-



South Side of the New Mill of the Norfolk Portland Cement Corporation.

where the material is picked up by bucket conveyors and brought to the driers, which are four in number. From the driers the material is dumped into pits and carried by bucket conveyors to pot crushers of the Mosser type, two of which are for clay and four for marl. After passing through these crushers the material is then elevated by bucket conveyors to storage bins, from which they are fed through automatic scales, which measure the marl and clay into exact

material is dumped into bins feeding into screw conveyors, which carry it to the kilns.

The coal grinding house, in which the coal is prepared for burning in the kilns, is separated entirely from the rest of the plant. This is done in order to protect the plant against fire or explosion. The coal is brought by screw conveyors to large steel tanks, which feed into driers, and from these are elevated to storage bins and fed into Griffin mills installed by the Bradley Pulverizer Co., Boston, Mass. These mills pulverize the coal, and from them they are brought by screw conveyors to the kilns.

The kilns are five in number and are 7 ft. 6 in. in diameter and 125 ft. long. After being burned in the kilns the raw materials come out in the form of clinker and are conveyed to five large coolers having perforated iron pipes running through the center for the purpose of reducing the temperature of the clinker. From the coolers the clinker is conveyed to four pot crushers, and from these elevated to long steel bins, which feed directly into eight 40 in. Griffin mills, which complete the crushing and pulverizing of the clinker. From the Griffin mills the now finished product is carried by screw conveyors to the stockhouse.

This structure is 250 ft. long and 80 ft. wide, and is built of reinforced concrete. It has a capacity for storing 200,000 bbls. of Portland cement. This warehouse will be used for storing material that is to be shipped by rail, while on the loading wharf is another warehouse 80 ft. by 100 ft., having steel structure and corrugated sidings and roofing, which will be used for storing the cement that is to be shipped by water.

The various buildings of the plant, together with their dimensions, are as follows: Raw storage building, 92 ft. by 100 ft.; raw drying building, 92 ft. by 120 ft.; raw grinding building, 62 ft. by 167 ft.; engine house, 75 ft. by 110 ft.; boiler house, 45 ft. by 120 ft.; coal grinding building, 70 ft. by 160 ft.; kiln building, 92 ft. by 170 ft.; clinker grinding building, 60 ft. by 170 ft.; cement stockhouse, 80 ft. by 250 ft.; stock house on loading wharf, 80 ft. by 100 ft.

The power plant is equipped with four boilers, developing 2,500 horsepower, and three cross-compound



Installing a Large Dryer in the Norfolk Portland Cement Plant.

proportions. After passing through the scales the raw materials for the first time since entering the plant come together. From the scales the materials are fed by buckets to round storage tanks, which feed directly into four Mosser rolls, which thoroughly pulverize and homogenize the marl and clay. After pass-

Corliss engines. The plant is fully equipped with all necessary auxiliary machinery.

These buildings are of steel frame structure and corrugated iron roof and siding, the steel structure being erected by the American Bridge Co. The foundations for the various structures, and also the masonry throughout the plant, are of concrete, and 10,000 cu. yds. of this material was used. The plant was designed by John Greenall, of Allentown, Pa., in connection with John W. Eckert, president of the American Cement Co. of Pennsylvania, and the resident engineer in charge of construction was H. F. Bascom.

Alongside of the large cement stock house has been built a siding of the Norfolk & Portsmouth Belt Line, which connect with all of the lines entering Norfolk and Portsmouth and gives this plant, therefore, the same advantages for shipment as if it were located on one of the many important railroad lines entering these cities. The lines of railroad having connections with the Belt Line embrace the three great Southern systems (the Atlantic Coast Line, Seaboard Air Line and Southern Railway) and the Norfolk & Southern, all extending to the south; the New York, Philadelphia & Norfolk, extending to the north, and the Chesapeake & Ohio, Virginia Railway and the Norfolk & Western, extending to the west.

At the company's docks which are almost directly opposite the Portsmouth navy yard, there is a depth of 30 ft. of water, affording opportunities for not only the coastwise, but the export shipping trade as well, and by reason of this fact, and its remarkable railroad facilities, the company is in a splendid position to serve quickly in large volume a large and important consuming area.

UNDERPINNING CEMENT KILN CHIMNEYS.

The Crescent Portland Cement Company at Wampum, Pa., has two groups of kilns each served by three brick-lined steel stacks 5½ ft. in exterior diameter and 80 ft. high above a rectangular brick footing about 18 ft. high. These walls were capped by square cast-iron plates supporting the 25-ton stack some distance inside the faces of the walls. The lower surface of the plates, being unprotected, were exposed to fierce flames, which, together with the heavy loads, developed cracks threatening the safety of the chimney.

To repair and protect them an underpinning contract was awarded to the John Eichleay, Jr., Company of Pittsburgh. The stacks were braced together by horizontal longitudinal lattice girder struts about 60 ft. above the ground with X-braces between them and the bottoms of the stacks. They were also braced by guys with ratchet adjustments at right angles to the line of struts. The broken base plates were at first reinforced by 8-in. steel plates about 5 ft. long placed on opposite sides of the stacks close to the foundation walls and serving in a measure as splices for the broken base plates. They were at first supported on vertical shores on 5-ton jack screws bearing against a horizontal ground sill.

Independent supports for the stacks having been thus secured and some of the load transferred to the shores, holes were cut through the brick walls about 12 in. clear of the base plates and through them 10 in. I-beam needles inserted under the center of the stack were supported on horizontal caps fitted between the channel buck stays of the brick walls and bearing on vertical shores and jack screws.

Segmental girders made with pairs of 10-in. channels back to back, curved to the circumference of the stack and covering about one-third of it, were thor-

oughly bolted to the steel plates underneath so as to align and reinforce the broken base plates. Additional shores were placed under the needle caps, making altogether four on each side; more holes were cut in the brick work and 9-in. needle I-beams were placed under the edges of the stack. Caps on which the needles rested were braced by raker pieces with their feet engaging the base of the adjacent walls and bearing on mud sills which extended back to the chimney footings and served also to brace the latter.

The eight jack screws under each stack were then operated to lift it from the original footings which were removed and replaced by new brickwork corbelled inside to form a dome-like mass carried inward to the edge of the stack and affording it both support and protection from the flames. The new work was wedged up against the horizontal plates, the jacks slacked off, transferring the entire weight of the structure to it and enabling the needle beams, caps, shores and jack screws to be removed. The work was done by eight men in about 12 days and the stacks were out of service only about 12 days each.

TRAFFIC MANAGER FOR CEMENT SHOWS.

The Cement Products Exhibition Co., 72 West Adams St., Chicago, has taken a step in the right direction in appointing Mr. F. E. Guy, Frick Building, Pittsburg, as Traffic Manager. Mr. Guy is an expert in transportation matters and should be of great assistance to the exhibitors and to the management in looking after and advising as to the shipping, routing, rating and delivering of exhibits, securing reduced rates from the railroads and so on.

Considerable difficulty has been experienced in past exhibitions by the exhibitors in shipping their exhibits so as to arrive at their destination in time for the opening of the shows at the lowest rates and with the least amount of trouble. This is particularly true of New York on account of the congested and complicated freight handling conditions in that district.

It is the intention of the Cement Products Exhibition Co., to fully inform the exhibitors at the Cement Shows as to the service Mr. Guy is prepared to render in looking after the consigning, routing, shipping and delivering of material for exhibition at the Cement Shows.

A PREMIUM ON FIREPROOF CONSTRUCTION.

Many towns are today offering special inducements to attract new industries. They make a practice of offering free factory sites, free water or exemption from taxation for a term of years to prospective manufacturers. It would seem to be of equal public benefit to offer concessions to obtain fireproof building construction. Each new structure would act as a fire stop, and ultimately fire fighting costs would be greatly reduced. The lowering of insurance rates alone is often not enough of an incentive to owners to adopt the safest construction, but the municipalities might readily offer the additional influence, perhaps, of a moderate tax reduction which would bring about a revolution in building construction.

At present we are saddling future generations with an ever-increasing burden for fire protection made necessary by non-fireproof construction. If it were made an advantage to owners to build fireproof, it would in the end result in a decided saving, through the decrease of unproductive fire-fighting costs. In even a greater measure it would afford a needed protection to life and property.

The Problem of Waterproofing

The Properly Built Concrete House is Damp Proof

By Ralph C. Davison

Probably one of the greatest obstacles to the rapid spread of concrete construction today, especially for private dwellings, lies in the idea which has gained a hold on the general public, that all concrete structures are damp. The task of convincing them that this is not so has been made harder by the erection of a number of so-called concrete structures, which are without question more than damp. Many structures of this kind have been erected by men who knew little or nothing about the material, and they have done more to retard the advance of concrete construction than one can tell. Dealers in rival building materials have taken advantage of these examples and with them have tried to show prospective builders how impossible it is to obtain a dampproof concrete building. Concrete if made rich is waterproof enough for all practical purposes, but from a commercial standpoint this is not practical for the reason that so much cement would have to be used that concrete would not be economical. Therefore the question of waterproofing, even good commercial concrete, is an important one.

There is a large and growing demand for good water-proofing materials. Probably nothing will show this better than the statement that some six to ten years ago there were about two or three firms, at the most, who were making materials with which to waterproof cement. Today there are probably upward of fifty at least and a new one coming into existence every month or two. Notwithstanding the number of the above companies they all seem to be making enough to exist on, which goes to show that the field for a good concrete waterproofing is practically unlimited. The writer will not attempt to go into the details of the merits or demerits of any of the above waterproofing materials, as this article is not intended to be a treatise on waterproofing, but is merely intended to impress upon the prospective builder the importance of waterproofing concrete and to give a general idea of how the waterproofing question can be attended to so as to secure a perfectly dampproof concrete house.

The waterproofing of the foundation and the parts of the cellar walls which are below grade will first be considered.

It is surprising, especially in the construction of small houses, how little attention has been given to below grade waterproofing by architects and builders. It is of the utmost importance, not only from a commercial point, but for the ultimate efficiency of the work, that the structure be designed from the start with a due regard to waterproofing. The above fact cannot be too strongly emphasized, for it will prove both a loss of time and money to build without in some way caring for the waterproofing, for the reason that when a building that is once up starts to leak, it is, in most cases, a costly procedure to make it water tight. Indeed, in many cases, it is almost impossible to do so without sacrificing space or tearing away a good part of the finished work in order to apply the necessary waterproofing materials. Local conditions largely govern the methods to be used in below grade work. If there is water pressure to contend with,

great care must be taken. Probably the best and most successful method to use in this class of work is shown in Fig. 1. The materials to use should be either some form of asphaltic compound or coal tar pitch, in connection with from one to six ply of waterproofing felt or fabric. The number of layers of felt to be used is dependent, largely, upon the water pressure which has to be resisted.

First of all, where space will permit, the excavation should be made large enough to provide sufficient room around the outside of the foundation walls to allow ample space for the proper application and handling of the materials. Then after the footing is laid a course of waterproofing should be applied on the top of it, covering it from edge to edge, as shown at a in the small detail A in Fig. 1.

On top of this should be erected the foundation wall, allowing the waterproofing course to project on each side of it, as shown at b b. When the foundation wall has been completed, the portion of the waterproofing which projects on the outer side of the footings should be turned up against the bottom of the foundation wall and securely cemented to it with either asphalt or coal tar pitch, as shown at e in the small detail B in Fig. 1.

After this has been done, the next step is to apply a waterproofing course to the outside of the foundation wall from the ground or grade line down to the top of the footing, as shown in the small detail C at d in Fig. 1, care being taken to see that it laps over and is well cemented to the part c of the waterproofing course which has just been turned up against the bottom of the foundation wall.

The waterproofing of the cellar floor is next to be cared for. The rough concrete foundation for this should be brought up flush, or on a level, with the top of the footing and should be made fairly smooth. To this surface should then be applied the waterproofing course for the cellar floor; care must, however, be taken to see that it laps well over the waterproofing layer which is already in place on the top of the inner side of the footing, as shown at e in the small detail C in Fig. 1.

After this waterproofing course is in place the necessary thickness of concrete to resist the existing water pressure should be laid over it. By following the method thus described one will have a continuous waterproofing course throughout the entire foundation which, if properly laid, will result in the procuring of an absolutely dry cellar, regardless of how wet or damp the ground around the house may be.

If space does not permit of placing the waterproofing course on the outside of the foundation walls, a curtain wall, as it is called, made of one thickness of brick or lean concrete, may be set up. Then on the inner side of this wall, as shown in Fig. 2, the waterproofing should be applied.

The foundation walls proper can then be set up or cast directly against the waterproofing course. Thus a continuous course of waterproofing is obtained throughout the entire foundation, as in the first method, but it entails, as explained, the additional cost of

erecting a curtain wall. It is only necessary to use the above methods where there is more or less water pressure to contend with. If one only has dampness to provide against, one or more good heavy coats of asphalt or tar applied hot on the exterior sides of the foundation walls will prove efficient. In cases where there is but slight dampness to contend with, one of the many preparations of asphalt in semi-liquid or liquid form, which can be applied cold with a brush, will be sufficient to prevent the dampness from striking through. This is a cheap method and has proved most effective in many cases.

When filling in the ground around a foundation treated in the above manner, care must be taken that no sharp stones, glass or tin cans come in contact with the surface, for if they do they may cut or abrade the dampproof coating. In many instances a thin layer of cement is plastered over the dampproofing course in order to protect it from any damage that might occur from the above cause.

Other methods of waterproofing concrete for below grade work are used; they consist chiefly of what is technically known as the integral method, by which is meant the incorporation into the cement of some foreign substance, which is much finer than the parti-

waterproofing course, as explained at first, in which there is more or less flexibility, allowing it to bridge over any small cracks which may develop owing to settlement, so that the structure will still remain intact and be efficient.

The dampproofing of the exposed walls will be considered next. There are various methods used, such as dampproof compounds, which are applied on the inner side of the walls—so-called colorless liquid solutions which are applied to the outside face of the walls and colored waterproofing paints which possess the advantage of decorating and waterproofing at the same time. If a dampproofing compound is used it should consist of a base of pure asphalt thinned down with some light oil, such as benzine, to a suitable consistency for spreading with a brush. It should also possess the properties of remaining "tacky." Some dampproof compounds on the market dry out very quickly and lose their "tackiness." This is a poor feature, and one which should be guarded against, as they then lose their flexibility and also their efficiency for bonding well with the plaster. These compounds are all black in color, and are only applied on the inner surfaces of the exposed walls in order to prevent the penetration of dampness. They are largely used as a

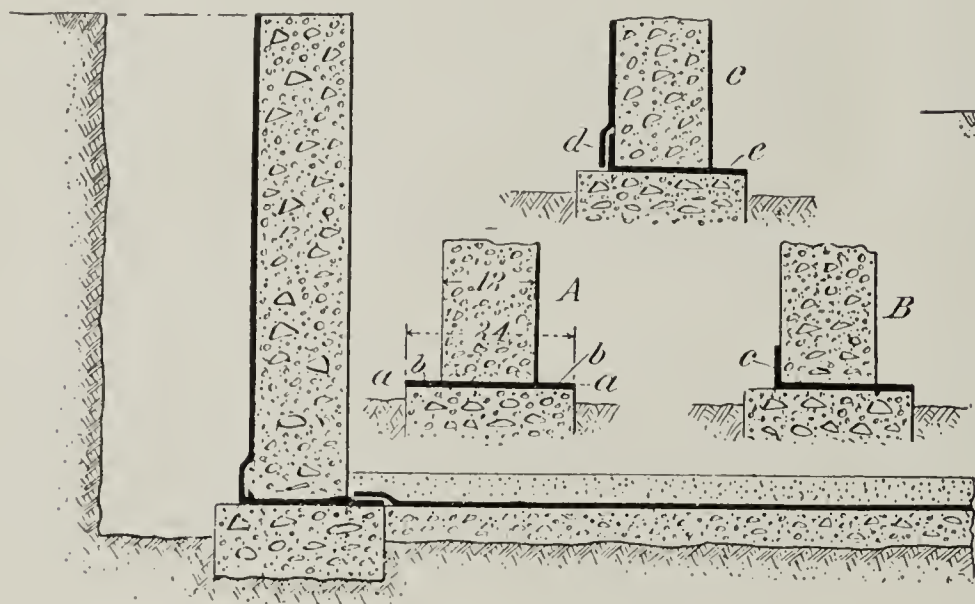


Fig. 1.—Practical methods of applying below-grade waterproofing.

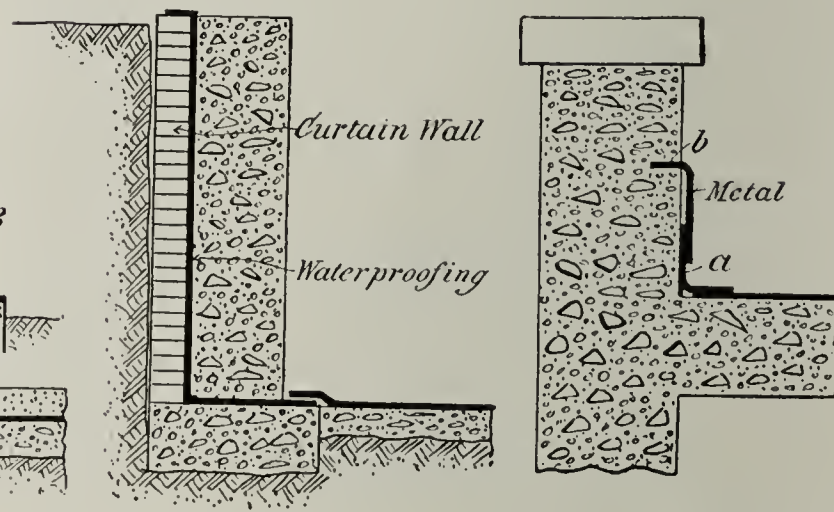


Fig. 2.—Below-grade waterproofing in limited quarters.

cles of cement used. The fundamental principle of this system is to mechanically fill the minute voids, which not only theoretically but practically do exist, between the grains of sand and the particles of cement, and to thus render the mixture denser and less pervious to dampness. There are many substances on the market, bearing various trade names, which are advocated by their makers to be used for the above purpose. Some of these are in liquid form, others in paste form, and again many are in the form of a finely ground or air floated powder.

One of the most common materials used for this purpose, and with considerable success, is hydrated lime. Five per cent by weight of this material added to the cement used will give excellent results, without interfering in any way with the strength of the concrete. There is no question that good results have been and can be obtained by the incorporation into the mass of such materials as mentioned above. The only objection which the writer has to this method of waterproofing concrete is that in case of settlement in the foundation, cracks will develop. If one could be assured that there will be no settling, then it would be safe to use the integral method of waterproofing. But where there is any doubt it is best to use a regular

substitute for wood lath, metal lath or hollow furring blocks, or they may be used in connection with any of the above in order to insure an absolutely dry air space. If used alone, it is well to specify two coats over which the plaster can be directly applied, thus doing away with the air space and the additional expense of furring.

The above method of dampproofing is largely used even on some of the highest class apartment houses and loft buildings, but it does not keep the driving rain from entering into the outer surfaces of the porous brick or concrete walls. What it does do is to form a waterproof film between the inner side of the walls and the plaster and thus prevents the dampness from soaking into the plaster as it otherwise would do. Many object to this method of dampproofing for the reason that it does not protect the outer surface of the wall, as stated above. A concrete wall saturated with rain not only takes a long time to dry out, but its appearance for two or three days after a storm is anything but pleasing, inasmuch as it dries out unevenly, which causes it to present a blotchy and unsightly appearance. Therefore many architects preferably treat the outside of the wall with a good waterproof paint and in many cases, where they have doubts

as to the waterproofing qualities of the outside treatment, they make doubly sure, and treat the inside of the walls as well with a dampproof compound as explained above.

A word here in regard to the proper paint to use for coating concrete may not be amiss. If linseed oil paint is to be used great care should be taken to see that the concrete or cement which is to be painted is at least one year old. This will give it ample time to thoroughly cure and dry out. Then before painting, the surface should be well washed with a weak solution of muriatic acid followed by a thoroughly good washing with clean water. This will not only clean the surface, but will help to neutralize the alkali in the cement, which, if left there will saponify the oil and cause the paint to crack and peel off. Care must be taken to see that the wall is entirely dry before painting is started if good results are desired.

A number of special coatings for cement have recently been placed on the market, the makers of which all claim that they will successfully withstand the action of the alkali in the cement. It is the action of the alkali in the cement which causes the destruction of an ordinary linseed oil paint, especially when applied to a new concrete surface. The waterproofing qualities of a number of these special cement coatings are in many cases greatly overdrawn. Therefore, in selecting a paint the purchaser will do well to test it for himself. The simplest way to do this is to procure a

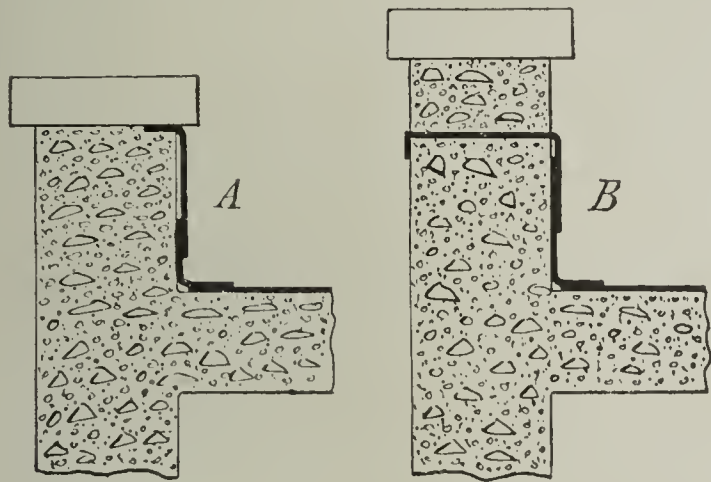


Fig. 3.—Various methods of applying flashings and counter flashings.

fairly porous brick and give it as many coats of paint as are intended to be given to the wall which is to be painted. (Two coats are always better than one, especially if a light color is to be used.)

After the coating on the test brick is thoroughly dry, have it weighed and make a note of the exact weight. Then put the brick in a pan or pail, in which there is just enough water to completely cover it. Allow it to remain submerged for at least twelve hours, and then remove it and after wiping off all of the surface water again weigh it, and compare its weight with the weight before it was submerged. The difference in weight will show just how much water went through the coating and was absorbed by the brick. Make a number of tests as described above with various paints, keeping careful notes of all results. The paint which shows the greatest water resisting qualities will be the one to use. In making the above tests be sure to see that the bricks are thoroughly coated, and that plenty of time is given for the paint to cure or harden before they are submerged in the water. Aside from the colored coatings mentioned above there are a large number of so-called colorless waterproof coatings on the market.

These are intended for use where one wishes to retain the natural color of the concrete. They are also largely used as a preservative for limestone, sandstone, etc. Probably one of the oldest materials used for this purpose is the ordinary commercial paraffine. This is applied to the surface hot with a brush. Then the surface thus treated is subjected to heat, which opens the pores in the stone or cement, and allows the paraffine to enter into all of the small crevices and voids, thus sealing them up and preventing any further moisture from entering into the mass.

All the commercial waterproofing preparations depend for their action on the principle of penetrating into the mass and filling up the voids. Most of them are sold in liquid form, gasoline being used as the solvent and saturant. Care must be taken in using materials of the above nature, as the majority of them accomplish their object by the incorporation of wax and grease. Therefore, if they are used to excess a most objectionable greasy and glossy appearance will be given to the surface. This is especially true if they are used when the weather is at all cold.

Aside from keeping the dampness from penetrating through the concrete, a good waterproofing will also help materially in preserving the surface from deterioration caused by the elements. Every one who has paid any attention at all to concrete has noticed the small cracks which appear on its surface. Waterproofing the surface will, to a large extent, prevent these cracks, as in many cases they are caused by dampness penetrating through the surface and then freezing. It is especially important to waterproof the surface of cement stucco which is applied on metal lath. For if this is not done, the moisture will penetrate through the cement and attack the metal, thus causing it to rust out and decay. The integral method of waterproofing is often used for stucco work. This has proved very successful in many instances. Care must be taken, however, to see that the hydrated lime or other compounds or liquid preparations which may be used are thoroughly incorporated throughout the mortar.

The waterproofing of concrete roofs is accomplished in a manner similar to that used for roofs which are made of other materials. Any of the good ready roofing materials may be used, laid as recommended by their makers. Tar and felt, as well as asphalt and felt, are also used extensively.

One of the principal things to care for is to see that ample flashings and counter-flashings are provided for around all projecting parts, such as parapet walls, skylights, ventilators and chimneys.

In Fig. 3 is shown the proper method of arrangement for the flashing and counter-flashing. The flashing is shown at a and it should be turned up against the parapet wall for a distance of at least eight to ten inches. The counter-flashing, which preferably is of metal, should project into the wall as shown at b. It should start at about twelve inches from the surface of the roof and should be allowed to project over the flashing to within about two inches from the surface of the roof. The inner section of the parapet wall above the flashing should be given a good coat of waterproof paint, so as to protect it from the weather. This is important, for if not done, water will get in and percolate down through the wall. If the parapet wall is not too high the counter-flashing can start from under the coping as shown at A, Fig. 3, in which case the waterproof coating may be omitted.

Very often, in new work, the waterproofing course is extended through the entire thickness of the parapet wall, as shown in Fig. 3 at B. This eliminates any

trouble that might arise from leakage due to moisture coming in above the flashing, or from any water that might get into the wall through the joints in the coping.

Aside from the roofing materials mentioned above, there are plastic roofing compositions which have given excellent results. These are applied with a trowel like mortar and are more or less elastic in their nature, and thus allow for a certain amount of expansion and contraction. Aside from their being waterproof they are fireproof as well, but as in the majority of ready-roofing materials the ingredient used in their composition is held as a secret.

For the waterproofing of concrete swimming pools, tanks, etc., a course of tar and felt or asphalt and felt may be employed, using the same general methods for application as described for the waterproofing of foundations. If the tanks are well reinforced, so as to provide against expansion cracks, and a good rich mixture of concrete is used, the integral method of waterproofing, however, will produce good results.

If leaks should develop owing to small expansion cracks, they can be completely sealed up by a liberal coat of asphaltic paint applied to the inside of the tank. Another method employed is to build the tank with a more or less lean mixture of concrete and, when this is completed, to apply to the inside surface of the walls a good rich cement mortar troweled hard and smooth. Many incorporate into this coat one or the other of the many liquid or powder form of waterproofing compounds. This method has proved most successful, not only for tanks, but also for the repairing of leaky cellar walls and floors. In waterproofing, always remember that the waterproofing, no matter of what material, should always be applied to side of the walls nearest the source whence the water comes. This in foundation walls is generally from the outside, and in tanks is always on the inside of the walls.

In conclusion, it should be said that weather conditions, as well as thorough workmanship, have much to do with the final efficiency of waterproofing. Better results can always be obtained in warm weather than in cold. So bearing this fact in mind, never have waterproofing applied in winter time, unless it is absolutely essential.

LOWER RATES ON CEMENT TILE.

Mr. Henry J. Lange, Carlsbad, New Mexico, advises us, says Cement Era, of the lowering of freight rates on cement tile into the Pecos River Valley by the Santa Fe Railroad. The new rate, as announced in the letter sent out by an official of the road, is as follows: Carloads, when loaded in stock cars, six inches and under in diameter, minimum of 40,000 pounds, rate of 20 cents per hundred pounds, and on diameters over six inches a minimum of 30,000 pounds, 22 cents per hundred from Kansas City and Kansas City territory to points in the Pecos Valley, Roswell to Carlsbad, inclusive, and from St. Louis, Mo., when routed via the Wabash Railroad in care of the Santa Fe at Lexington Junction, 6½ cents per hundred pounds higher; the restriction as to character of the equipment employed to be waived when from the latter point.

The letter states that this reduction is made only after a careful personal inspection of condition in the valley, and a belief in the great good which will result from drainage.

NOTICE TO PUBLIC.

IN THE UNITED STATES CIRCUIT COURT OF APPEALS.

For the Third Circuit.

No. 1376.

Williams Patent Crusher & Pulverizer Co., Appellant.
vs.

Pennsylvania Crusher Company, Appellee.

Final Decree on Mandate.

On reading and filing in this Court the mandate of the United States Circuit Court of Appeals for the Third Circuit, bearing date April 24, 1911, in obedience to said mandate and in cognizance of the opinion of the said United States Circuit Court of Appeals:

1. It is this nineteenth day of June, 1911, hereby ordered, adjudged and decreed that claims 1 and 2 of letters patent No. 843,729, dated February 12th, 1907, granted to the Williams Patent Crusher & Pulverizer Company of St. Louis, Missouri, a corporation of Missouri, for Dumping Cages for Crushers and Pulverizers, are good and valid in law, and that Milton F. Williams, upon whose application said letters patent were granted, is the first and original inventor of the invention therein set forth.

2. It is further ordered, adjudged and decreed that the complainant, the Williams Patent Crusher & Pulverizer Company, is the sole and exclusive owner of all right, title and interest in and to said letters patent, and that the defendant, the Pennsylvania Crusher Company, has infringed said claims and on the exclusive rights of the complainant under said letters patent by making, using and selling crushing machinery containing the dumping cages and operating mechanism therefor set forth in said claim.

3. It is further ordered, adjudged and decreed that the complainant do recover of the defendant all of the profits, gains and advantages which the defendant has derived, received or made by reason of said infringement of said letters patent, and that the complainant do recover of the defendant any and all damages which the complainant has sustained by reason of such infringement.

4. It is hereby referred to _____ as a Master of this Court who is hereby appointed, pro hac vice, to take and state the amount of said gains, profits and advantages and to assess such damages and to report thereon with all convenient speed; and the defendant, its directors, officers, attorneys, clerks, servants and workmen are hereby directed and required to attend before said master from time to time as required and to produce before him such books, papers, vouchers and documents, and to submit to such oral examination as the Master may require; and the Master is instructed to consider the evidence already taken in this case, and the exhibits in evidence, and such further evidence as may be taken.

5. It is further ordered, adjudged and decreed that a perpetual injunction issue out of and under the seal of this court directed to the said defendant, the Pennsylvania Crusher Company, its associates, directors, officers, attorneys, clerks, agents, servants and workmen, enjoining, set forth and claimed in claims 1 and 2, or from infringing upon or violating claims 1 and 2, of said letters patent in any way whatsoever.

6. It is further ordered, adjudged and decreed that Complainant do recover of the defendant its costs, charges and disbursements in this suit to be taxed, and that the question of increase of damages be reserved until the coming in of the Master's report.

Λ Cross-Beam Concrete Floor System

By Arthur Peabody.

One of the chief expenses in reinforced-concrete work is the false framing upon which the concrete is poured. About 50% of the lumber used in making falsework is usually destroyed on taking down. Any system by which the major part of this can be saved results naturally in a decrease in the total cost of the building. In applying concrete construction to small work the scale of parts involves expensive and intricate preparation of false work so that the cost of this part sometimes exceeds the value of the concrete poured upon it.

There is room for trouble in constructions where a certain beam supports a considerable area. Such a beam is usually calculated to do the work intended, with a good margin of safety, but suppose the casting of the beam proves to be faulty, or in some manner the beam suffers slight damage. At once the entire area is threatened. This suggests the arrangement of many beams of small size, each supporting a small floor space. To this there arises the objection of increased cost. Beams of long span and narrow width suggest cross bracing, and again the comparison with wood construction suffers as regards expense. The good elements of wood construction are, however, precisely those of advantage in concrete. Wood beams are of long span, slight dimensions, and are set closely together. Each beam is braced to its neighbor by cross bridging. Under the beams all sorts of pipings are extended, and a flat ceiling is placed beneath. Upon the beams the floor is laid. What could be more reasonable and convenient? Should a pipe fall it requires only the removal of the ceiling for its repair. Should it be necessary to change the dimensions of rooms the necessary readjustments are readily made. Should a beam be slightly defective, or suffer injury, the beams adjacent will support the load, or if necessary, a section can be replaced without removing a large area of the floor. None of these advantages are to be had in the "mill type" of floor construction.

A system employed at the University of Wisconsin has been found practical, economical and effective, and for buildings intended for ordinary use more satisfactory than the "mill type" of construction. In competition it has been found less expensive where the requirements of the specifications for the steel and other elements forming a necessary part of good construction have been conserved. This has been put to proof by obtaining alternate propositions on the same work, imposing only the requirement that the steel shall be strained not to exceed a certain amount, that spaces shall be provided for pipes, etc., and that the ceilings shall be flat.

Other systems approach the practical values of this one in some degree, as for instance that one where hollow tiles are used in place of the wood cells. Where but one building is to be constructed the cost of the cells might excel the cost of the tile. Where the building is of several stories, or in buildings of large enough area so that one part can be constructed before another, thus permitting the repeated use of a reasonable number of cells, the cost of the tile would probably exceed the proportionate cost of wood cells. The tiles serve no useful purpose except as forms between which the beams are cast, and their weight adds

to the dead load of the floor construction. In either case a floor sheet must be placed on top, and the ceiling must be furred to receive piping and other accessories. Of course, such pipes may be buried in the floor sheet, but there is serious objection to this. It is done in most fireproof buildings, but the expense of repairing damage in case of leakage of water, gas or electrical current is made very heavy on account of it. Changes also are very expensive and difficult, and it is safe to say that every building will be changed over a number of times before it becomes obsolete.

The system or design of the floor construction in use at the University of Wisconsin consists of an arrangement of narrow beams spaced at about 3 ft. centers and braced by cross-beams at 6½ ft. centers. The beams are formed by employing a series of wooden boxes, with slightly flaring sides and ends, laid face down upon a system of supporting planks upheld by shores. The intervals between the boxes or cells being filled with concrete constitute the beams and cross-braces of the floor. The concrete is reinforced with steel after calculations made by the Dean of the Engineering Department of the University.

Upon the beams a floor sheet is poured, reinforced with steel wire fabric and finished with a wearing surface of cement and granite "fine stuff."

The reinforcing steel consists of round rods enclosed in loose stirrups. In the girders the rods are bent according to the best practice. Straight rods are used in the joists with counter flexure rods over the girders. In the cross braces small single rods are placed. The stirrups are of the U form, but to secure correct spacing and holding, several stirrups are bent from a single rod forming a unit series. These have been found very convenient on account of stability and resistance to drifting, falling and other annoying peculiarities of single stirrups. Mild steel has been employed in all work. High tensions have been prohibited, as well as calculated tension in concrete. This may be conservatism, but is no doubt wise. The effort of the architect has been to simplify and reduce the cost of work and to retain the good elements of old-fashioned constructive systems; to provide reasonable means of access to parts for repair and changes and to bring back the forms of surfaces on the interior of buildings which long custom has found most suitable and agreeable.

The rough way in which concrete is now mixed and cast, the danger of imperfect castings and the liability of damage to concrete in stripping forbid the use of very slender parts at present. For private house work the concrete floors of today are probably excessive in strength. Refinement in the falsework and casting will come in time, however, and it is to be expected that future constructions will be very much lighter and less expensive.

By the system described, spans from 12 to 26 ft. have been successfully cast at the University during the past two years. It is proposed to cast beams of 28-ft. span this year. These will require joists 8 in. wide on the bottom, 14 in. deep and 10 in. wide on top. With a spacing of 3 or 4 in. from center to center of joists the amount of concrete employed does not seem excessive. The cross braces in the floor, due to the in-

ervals between the lengths of cells, have not been considered in the estimated strength of the floor. Their value in holding the joists, against lateral strain is unquestionable and they serve also to distribute the load upon the floor. The increased width of the beams at the top, due to the flaring sides of the molds gives increased resistance to crushing, while the narrower bottom, enclosing the steel, is sufficient and economical.

The calculated strength of the floor is entirely in the beams. That is to say, the floor sheet is not expected to increase the compressive strength of the joists as in the T-beam. The floor, reinforced with a woven wire fabric simply applies the load to the beams.

In casting this work the supporting columns are poured first and are left over night to shrink. The girders and beams follow, being also allowed to shrink, after which the floor sheet, almost a separate item, is cast and finished with cement and granite.

This method of working has been followed upon finding that heavy members need time in order to avoid cracking at the junction with the thin floor sheet. It has been found that the floor sheet may be cast at any convenient time, care being taken to clean the upper surfaces of the beams to secure good contact with the floor. In fact, with a sufficient number of boxes or cells an entire building may be constructed, casting the posts, girders and joists, but leaving the floor sheet to be placed after the building has been enclosed. For attaching the ordinary ceilings to this construction small strips of wood are cast into the bottom of each joist and secured by bent nails, thus affording a ready means of applying the furring strips for the ceiling. These in turn give the needed spaces for pipes, etc. Upon the furring strips wire lath or plaster board is nailed and the plastering is applied.

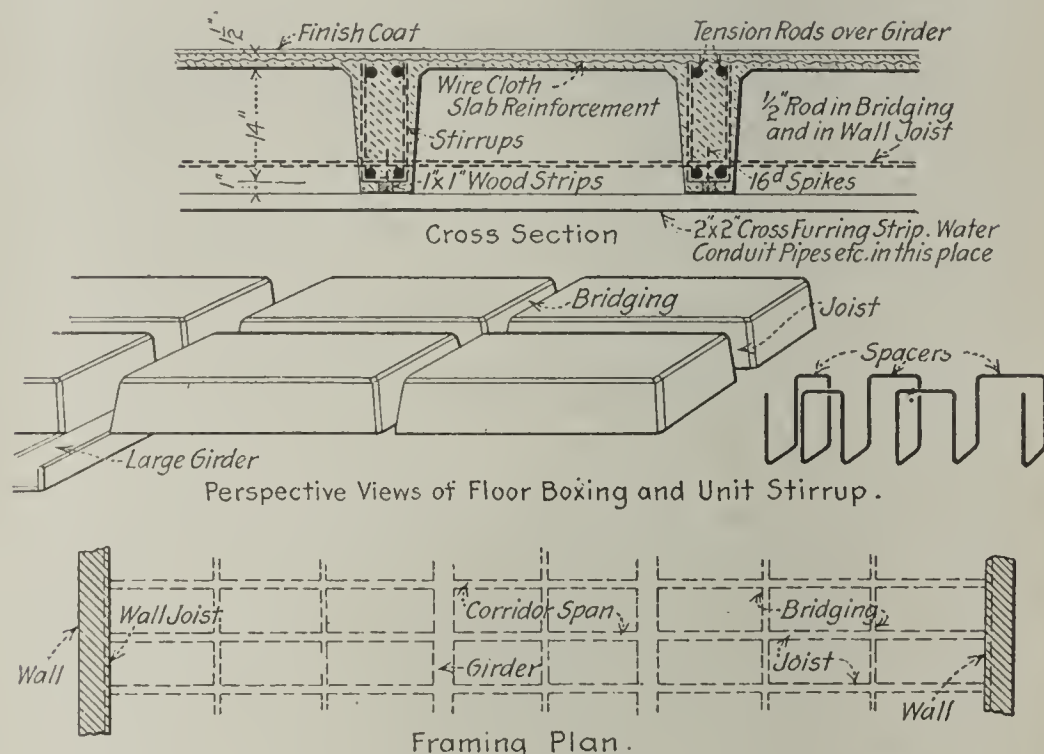
The falsework for columns and girders is composed of dressed planks put together in the ordinary way. These parts suffer the least injury in removal and may be set up a good number of times. The cells rest upon the girder boxing where adjacent, forming the falsework for the upper part of the girders. In other locations they are supported by the plank scaffolds above described or upon the inside edge of the walls. In all places they are carefully leveled so that the concrete cannot penetrate between the scaffold planks and the cells. A few nails from below hold the cells securely to the plank.

The spaces between ends of cells may vary somewhat, where convenient. Nice adjustments do not give great results where labor is expensive. Making the joists narrower on one side of a girder than on the other, on account of a slightly shorter span does not bring final economy at times. It is simpler to make the "lay out" regular and strong enough for the longer span.

With the completion of the falsework the floor is ready for placing steel and casting concrete. The supporting columns are poured first and while the concrete is settling the steel is placed in the girder and joist channels. The "unit stirrups" are set in the ends of the girders and joists, being held up from the bottom of the forms by the small wooden strips to which the ceiling furrings are to be nailed later. The stirrups confine the tension rods of the beams. The steel is laid in the girders and joists of the entire floor before any part is covered with concrete. It may be inspected all together, corrections made, and the pouring is then begun. As fast as the joists are filled with con-

crete the counter flexure rods of the joists are floated in the concrete, extending over the girders and the work is ready for the floor sheet. At the end of the day's work the concrete of the joists and girders is dammed off at the center of the spans and the work is resumed the next day.

The second day's work usually begins with pouring the floor sheet on the area completed the day before. The woven steel fabric is unrolled over the surface and the concrete poured upon it. When sufficiently hard the surface finish is applied and the floor is completed. The pouring of the remaining joists follows the part of the sheet, using a half day on the sheet and the other half day on the joists and girders so that no part of the unfinished floor is more than one day old.



Slab Reinforcement:— American Steel and Wire Company's Diagonal Mesh Wire Cloth. Style No. 26 or Expanded Metal; No. 9 Metal, 6" Mesh; or No. 10 Metal 4" Mesh (Birmingham Gage).

DETAILS OF CROSS-BEAM CONCRETE FLOOR SYSTEM.

TABLE OF SIZES FOR LIVE LOAD OF 60 LBS. PER. SQ. FT.

Span in feet.	Width of joists at bottom, in ins.	Reg. steel, area in square ins.	Number and size of rods.	Number and size of stirrup.
14	4.0	.375	2-1/2"	4-1/4" at each end.
16	4.0	.490	2-5/8"	4-1/4" " " "
18	4.0	.620	2-3/4"	4-1/4" " " "
20	4.5	.760	2-3/4"	6-1/4" " " "
22	5.0	.920	2-3/4"	6-1/4" " " "
24	6.0	1.100	2-7/8"	8-1/4" " " "
26	7.0	1.280	2-1"	8-1/4" " " "
28	8.0	1.500	2-1"	8-1/4" " " "

Practice has shown that the floor sheet is not separable from the joists even when poured after the joists have been set for several days. The finishing of the surface of the floor must be done, of course, soon after the sheet is poured. The entire work is allowed to set for three or four days before the mason work of the walls is allowed to proceed, but no stripping is done until after 14 days. The girders and posts are then stripped and the cells are drawn out from underneath. For this work a chain about the interior framing of the cell is looped over a stout lever and one end of the box is started, whereupon it falls out, ready to be used over again. Small shores are then placed under the joists and left for a short time.

The cells first made at the University were built of pine sheathed with yellow pine flooring quite smooth and carefully put together. These cells were successfully drawn and were used 15 times without a great percentage of loss. Their cost was approximately \$2.50 each. Each cell presented 28 sq. ft. of surface,

making a first cost of 8.9 cts. per sq. ft. After 15 casts the cost per sq. ft. remained at about 0.6 cts. per sq. ft., assuming that the cells were then worthless. The contractor then covered them with sheet iron, at a cost of \$1.40 each and expects to use them probably 15 times more. This iron covering is well greased before using.

At this time a good number of new cells were constructed, also covered with iron. These were well built but without the same care in smoothing the surface on account of the iron covering. These cells slip out of the concrete so easily as to show a great advantage in the use of a metal covering which presents a smooth unbroken surface to the concrete. It obviates also the swelling of the wood covering from dampness, which made the drawing of the first cells rather hard at times and destructive to the cell. The life of a cell depends, of course, on the treatment it receives. Some were wrecked the first time they were used. Many of them were in apparent good order except as to the lower edges after 15 casts. Their weight occasioned some damage, especially if allowed to fall to the ground on being drawn. The most convenient size of cells appears to be 2 ft. 8 in. wide by 6 ft. 6 in. long. Beyond this size they cannot be so easily handled. Some cells were made 7 ft. long and a few 5 ft. At times it is necessary to build special cells to finish out a span.

Variation in strength of floors was made in spacing the cells farther apart, making the concrete joists wider for the heavier floor. The percentage of steel was then increased according to rule. The joists were sometimes left exposed, over laboratories, and made a very presentable appearance. This gave opportunity for the convenient support of shafts, etc. Electric conduits were there left exposed, following the direction of the joists and cross bridgings. In other buildings plastered ceilings were attached in the ordinary manner. Steam coils were suspended from hangers secured by drilling the joists at the neutral axis. For line shafts, bolts were cast in the concrete at regular intervals, to which timbers carrying the shaft hangers were bolted.

The floor sheet, 2½ in. thick including the sand finish, seems fragile. Experience, however, shows that except for the mechanical difficulty of casting, the floor could be thinner. Floors have been broken during construction, but by blows which would break other floors considered amply strong. On one instance a scaffold plank fell about 16 ft., striking on end. At another time a piece of sand stone 3 ft. long, weighing about 450 lbs., fell the same distance upon the floor. Each of these accidents made a break about a foot square, leaving the steel fabric but little damaged, and the repair of the floor very easy. Drilling through the floor for extending steam risers or setting anchor bolts shows the strength to be ample if not excessive.

All floors thus far constructed have been covered with a finishing coat of cement and granite, following the usual method in sidewalk work.

An example of the use of the system, with resulting costs is shown in a floor constructed in the Mining Laboratory of the University of Wisconsin. The floor area was approximately 4,500 sq. ft. The superimposed load was taken at 200 lbs. per sq. ft. This work being done by the University forces gave an opportunity to know exact costs, as follows:

Per sq. ft.

Crushed limestone, sand and Portland	
cement	\$474 or 10.54 cts.
Lumber for girder and post forms, etc.	252 or 6.60 cts.
Cost of placing falsework and cells.	250 or 5.55 cts.

Cost of steel reinforcement.....	354 or 7.86 cts.
Labor of placing steel and pouring	
cement	200 or 4.44 cts.
Labor of removing falsework.....	50 or 1.11 cts.
Use of 200 cells at 1-15 original cost.	33 or .73 cts.

Total cost\$1.613 or 35.83 cts.

The cost of lumber for girder and post forms is of course too high, no allowance being made for the value of the material after removal. This lumber was not greatly damaged, but the exact value is hard to set down, as no subsequent floors of good area have been constructed by the University where it could be used. If the material could be taken to be as durable as the cells the proportionate lumber cost would be brought down to \$16.70 instead of \$252 and the total cost to \$1,387.70 or 30.84 cts. per sq. ft.

In applying this system it is to be noted that except in the items of concrete and steel a light floor will cost as much as a heavy one. It can be cast with the same cells, planks, shores, etc., and with approximately the same amount of labor. The increase on the heavy floor would of course be in the labor of pouring the larger amount of concrete. In the use of this laboratory the floor calculated to carry 200 lbs. per sq. ft. has been greatly overloaded, with no bad results, however, which indicates that the actual strength of concrete construction is probably far in excess of that calculated.

This suggests lower factors of safety or diminished sections, but chiefly, in building work, longer spans. The economies in materials are not great, as between a strong and a weak floor. The elimination of posts is of much greater interest. If spans up to 40 ft. could be safely employed the interiors of many buildings might be quite clear and the parts arranged in the most convenient way, unhampered by lines of supporting columns. With the present depth of 14 ins. for the cells there is of course an economical limit to spans. Deeper cells would bring a new set of calculated values, however, so that there may be no reason why long spans should not be made use of.

CERESIT'S NEW CATALOG.

The Ceresit Waterproofing Company, Commercial National Bank Building, Chicago, Ill., has just issued a new catalog showing the many large buildings and other important structures waterproofed with CERESIT since they invaded the United States market about three years ago.

It is the most complete catalog the company ever put out and contains many flattering testimonials from some of the largest contractors, engineers, manufacturers, dealers and architects throughout the United States who have used this popular brand of waterproofing.

The first part of the catalog tells what this product is, and what it will do and gives valuable information concerning the waterproofing of large and important works. Send for a copy.

J. Spaulding & Sons Co., manufacturers of leather board, Rochester, N. H., have just awarded to the Aberthaw Construction Co. of Boston, the entire Contract for the erection of a hard fibre mill at Tonawanda, N. Y. The construction will be of reinforced concrete and will include a main building 300x265 ft. one story high, except for 60 ft. of its length where it is two stories; a one-story machine shop 144x36 ft.; a one-story acid boiling plant 72x36 ft. and a power house. The work is to be completed for fall.

CONCRETE COAL BINS PREVENT DISASTER.

Spontaneous combustion is held responsible for a fire which started in the coal bins in the large establishment of Tibbs, Hutchings & Co., Minneapolis, Minn., several weeks ago. In these bins were 224 tons of coal, and the fire burned for several days before it was discovered. Employees detected a strong odor of gas, but it was believed to be from a broken gas pipe. Inspectors failed to find a leak and it was finally discovered that it was gas from the coal fire in the bins. It was some time after discovery before the fire was extinguished. All that time the fire had made progress. No fire spread to any other part of the building. The coal bins are of reinforced concrete, top, bottom and sides.

HOW TO HANDLE CEMENT SACKS.

The Lehigh Portland Cement Company in its June bulletin gives the following suggestions regarding the care of sacks which every user of cement would do well to observe:

1. Never throw bags on the wet ground, or keep them in a damp place, as they are likely to become badly caked. As the cement is dumped out see that the bags are placed in a pile in some dry spot.
2. Do not turn the bag inside out when pouring out the cement, but shake out well as you dump the contents.
3. Never cut a bag with a knife; they are then worthless and cannot be redeemed.
4. When packing, lay sacks flat and pack in bundles of 50 each, putting a separate tag on each bundle

Metal-reinforced-concrete timbering for mine tunnels is a patent recently taken out by Darwin W. Shepard, Denver, Colo., assignor to The Shepard Patent Cement Mine and Tunnel Timbering Company, same place.

SAND-LIME BRICK PLANT FOR BATTLE CREEK.

A large silica brick and stone plant—possibly the largest in the world—is to be located in Battle Creek, according to a statement given out by Louis F. Kaye, president of the International Sand Lime Brick & Machinery Company, of New York.

The Board of Trade of Miami, Fla., is lending approval and help to a proposition regarding the establishment of a sand lime brick plant. The suggestion has been made by H. H. Kirkpatrick, and it meets with very liberal endorsement by the board. The plant discussed would cost about \$20,000 and have a capacity of 12,000 to 15,000 brick per day.

CEMENT FLOORS.

Finished cement floors have for many years been common for cellars and porches of residences. With the advance of the industry many owners, convinced of the advantages of finished cement floors in the living rooms have had their houses built accordingly, laying rugs immediately over the cement floors. Ornamental colored floor tile has now come into the field and has resulted in a marked improvement, producing a floor which has all the strength, endurance, and sanitary properties of the ordinary finished cement floor and in addition a warm, pleasing effect. Mr. Geo. W. DeSmet of Chicago, donated this material for the floors of Miss Lillian M. Williamson's Cement Show Prize House.

CEMENT COMPANY ORGANIZES.

Articles of association of the Michigan Portland Cement Company, to be located at Gray village, Lima township, Washtenaw county, have been filed.

The company is organized with a capital stock of \$500,000 to manufacture and deal in cement. Four hundred thousand dollars worth of the stock is common and \$100,000 preferred. The preferred stock has the nature of a first mortgage under the provisions in the preferred stock are to be paid before the common is paid at all in case the company is forced to liquidate. The company is incorporated for 30 years, and \$50,000 of articles of incorporation which declare that holders shall receive cumulative dividends at seven per cent a year after July 1, the stock being redeemable July 1, 1921. Holders of the preferred stock are to be paid in full before the common is paid at all in case the preferred, Kennedy Potter, Jackson, 125 shares common and preferred; Clark Potter, Jackson, 125 shares common and preferred; Harriet Stewart, Cincinnati, 125 shares common and preferred, and Nathan Potter, Jackson, 3,500 common, 300 preferred.

The company owns the plant at Four Mile lake which after nearly a year of solid work in reconstruction is now one of the most complete cement plants of its kind in the state. By July 1 the plant will be in full operation manufacturing cement, and night and day shifts are employed. The output will be about 1,500 barrels per day.

THE CARDIFF CEMENT TILE MACHINE.

The Cardiff Cement Tile Machine has a remarkable record for durability. Considering its size it is claimed for it that the capacity for this machine is not paralleled by any other. The manufacturers claim that one of their machines has made over 100,000 tile for the owner who declares it to be as good as the day it left the factory. These machines are distributed in Colorado, Iowa, Illinois, Indiana, Minnesota, North Carolina, Oklahoma, Virginia and several other states. From all directions only good reports of their excellence are coming in. In every case it is reported that they are fully up to representation.

SILICA BRICK AND STONE.

The Tift Silica Brick and Stone Company, Albany, Ga., manufacture under the patented "Division" method. The plant has a capacity of twenty thousand brick daily, and is located on what is known as Sand Hill—a remarkable, natural formation of pure sand, the deposit extending to depths that have never been sounded, and the supply seemingly inexhaustible.

These white brick make a beautiful front for any store, and are not expensive either—costing only about ten dollars a thousand.

This brick, which is rather new in the South, is very common in the North, and is used extensively by the U. S. Government, several buildings at West Point being constructed of this brick. Many Northern cities have also used it for their municipal buildings.

Besides brick, the company manufactures building stone, lintels, cornices, etc.

The company is headed by Capt. H. H. Tift, Jr., of Tifton, and everything with which this progressive business man has any connection is a success. J. M. Tift is manager.



*Concrete Water Tower, Made
Perfectly Waterproof with
Ceresit Waterproofing*

Ordinary Waterproofing Compounds Weaken the Concrete Mass

Many engineers refuse to allow waterproofing powders to be used on their concrete construction, because the powders do not unite properly with the cement, sand and stone. They waterproof the concrete only in some spots and expose it in others. Nor will they allow mere washes or paints to be used, because they crack, peel and chip off, exposing the surface to the entrance of moisture and disintegration from frosts.

To effectively waterproof concrete, you must incorporate a highly efficient water repellant uniformly in the entire mass and the best known method is by Ceresitizing the concrete during the mixing of the cement, sand and stone.

"Ceresit" Waterproofing

Is an Integral Waterproofing

sold in the form of a cream white paste which is put into the water which is to be used in mixing the concrete and before the mixing is done. This Ceresitized solution of water is used, instead of plain water, in mixing the concrete ingredients and this solution carries the Ceresit water-repellant into every portion of the mixture. When the concrete mixture is completed it is uniformly waterproofed through and through.

Whether the concrete wall be six inches or six feet thick it is waterproofed throughout the entire mass and no water will ever get into it. Mere scratches or chips on the surface do not affect the water repelling quality of the Ceresitized mass.

The leading engineers in Europe and America recognize in **Ceresit** the most effective water resistant at the lowest possible cost. These men have used on tunnels, dams, reservoirs, swimming pools, sewers, foundations, bridges, aqueducts, viaducts, water towers, water tanks, cellars, floors, roofs, etc., etc.

No water pressure that **Ceresit** is required to withstand will affect its permanent water repelling properties. Continued pressure and age tend to increase the water resisting quality of Ceresitized concrete.

Ceresitizing is an absolutely trustworthy and safe method of keeping water out of the thinnest cement mortar coating that is ever used on structures built of concrete, brick, stone, tile, and for stucco and cement plaster surfaces.

We guarantee **Ceresit** to permanently keep water out of any concrete or cement construction when the work is done under our direction.

Ceresit is sold all over the world in barrels, and five and ten gallon jacketed cans.

CERESIT is Catalogued in "Sweet's" Index, Pages 46-47

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Concrete on Subway Work

An excellent example of what remarkable results can be obtained by adopting the proper methods of excavation and construction for a given section of subway work is afforded by the Tide Water Building Co. and T. B. Bryson, of New York, in the execution of their contract for section 11-A-3 of the Fourth Avenue Subway, in Brooklyn.

It is quite evident that the successful outcome of these plans has also been due to a considerable extent to the efficiency of the mixing machinery, engines, hoisting machinery and other apparatus selected to do the work. Without these it is highly probable that the final issue would have been exceedingly disappointing, inasmuch as at times, such as when concreting an 80-ft. monolithic section, the work demanded of such machines as the mixer was severe and continuous. A breakdown in the hoisting apparatus or a hitch in the mixing plant would have meant a tremendous loss when the continuous running of the concrete was absolutely essential.

The section under discussion is about 4,800 ft. long and extends along the hillside between Prospect Park and the Gowanus Canal. The standard section of reinforced concrete is 60 ft. wide by 19 ft. high, with a center and two quarter walls separating each of the two local and two express tracks which will be from 20 to 30 ft. below the street pavement. The design of the two stations in this division is of structural steel in connection with the reinforced concrete. The wall footings and all the track floors are of concrete as are also the benches located on either side of the subway each of which contains ten four-way ducts. Hollow tile is used on the outside of the outer walls, for water proofing purposes.

After relocating sewers, water pipes, gas pipes, cables, etc., outside of the subway cut, the main excavation work was begun, 85% of which was done by a 70-ton steam shovel. As Fourth Avenue is 120 ft. wide a wooden roadway 12½ ft. wide was built on either side with its supports outside the lines of the subway. Thus, as the material through which the excavation was made was firm, no cross-bracing was required and the cut was free from obstructions. Four cuts were made and at such a speed that the amount the Public Service Commission's engineers anticipated would be excavated in six months, from previous subway performance, was completed in two. The spoil was placed in side dump cars, hauled by locomotives about one-half mile to the Gowanus Canal and there dumped automatically from an elevated tippie, the tracks of which were set 10 ft. outside of the bulkhead line of the pier, into the center of barges, thereby avoiding any trimming. The total amount of excavations will be in the neighborhood of 300,000 yards place measurements.

Of especial interest are the mixing plant and the steel forms. The arrangement of the former is well worth the careful study of concrete contractors. The plant has been so designed that with a Ransome 1-yard mixer and the conveying machinery, it is capable of meeting the exacting requirements offered on days when a continuous hard 16-hour run is necessary. Its flexibility is well illustrated by the fact, that though 50 yards per hour is the average rate, 305 yards of concrete were placed in 5½ hours and this time includes all delays such as shifting of chutes, transportation, hoisting and dumping of buckets, etc.

With the exception of emptying the cement bags into the measuring hopper the concrete and its ingredi-

ents are handled mechanically from the time the materials are received at the dock until the mixed concrete is placed in the forms. The gravel and sand received at the company's wharf at the foot of Nineteenth Street and Gowanus Canal, are unloaded into bins by a locomotive crane and clam shell bucket, from where they discharge into dump cars and are hauled by 18-ton locomotives to the mixing plant in the cut at Nineteenth Street and Fourth Avenue. Coming into the section at street grade the gravel and sand are dumped into bins of about 2,000 and 1,000 yards capacity on either side of the mixing plant building. Below these bins are two separate horizontal belt conveyors discharging into a belt and bucket elevator which carries the materials to the top of the building where it is dumped into compartments from which lead chutes with gates to the measuring hopper. All of the conveying machinery is driven by one induction motor. The top of this measuring hopper is level with the floor, the elevation of which is the same as the tracks on which the gravel, sand and cement cars come in from the dock. The cement as received from the cars is piled around this room and as necessary the sacks are emptied into the hopper. The water used is measured in tipping barrels adjacent to either side of the hopper and filled from a 400 cu. ft. tank located on the side of the roof, the tank being connected to the city street main.

The contents of the hopper, generally proportioned 1:2½:4½, are emptied into the 1-yard Ransome mixer located on the lower floor. This is driven by an induction motor and runs at an average speed of 12 r.p.m. The tilting chute and swinging gate of the hopper are operated by one man who, at the same time, watches the filling of the buckets below as they come in on the cars running on parallel tracks on either side of the mixer.

The concrete, now thoroughly mixed, is hauled by locomotives to the section being constructed. Here automatic bottom dumping buckets are raised by a locomotive crane and discharged into an elevated hopper located on and about ten feet above the top of the forms. The mixture then runs down an inclined chute by gravity to the point desired. As the chute is pivoted to the hopper and has a wheel at its extended end it may be shifted to all parts readily.

The collapsible traveling steel forms are made in 5-ft. sections of the shape of each tube and weigh about 8,000 lb. per 5 ft. section of single tube. At the present time these are bolted together to form the standard 40 ft. sections. As the interior panels of all four tubes may be locked together by bolts, no bracing was required except for the outer walls, and therefore, the two express tubes are always clear.

The forms are mounted on wheels which run on rails riveted to a heavy angle which extends along and fits over the edge of the wall and bench footings. The design of a 40-ft. section of tube forms is such that the roof panels may be slacked off by the operation of four chain hoists. As this section takes place the side panels are also pulled in, leaving a clearance so that the tubes may be readily moved ahead.

It is very probable that there are few records of mixing, transporting, and placing concrete which could equal that made on this work. To date, about 40,000 cubic yards have been placed. In concreting an 80-ft. monolithic section 688 yards have been run in a day. In all cases the concrete has been inspected by the Public Service Commission's engineers. It is an-

anticipated that the ultimate amount of concrete placed will be 60,000 yards, with 2,500 tons of reinforced steel.

The Fourth Avenue Rapid Transit Subway is being built for the City of New York under the Public Service Commission, for the First District, of the State of New York. Alfred Craven, Acting Chief Engineer; Frederick C. Noble, Division Engineer; Henry L. Oestreich, Senior Assistant Division Engineer; by the Tide-Water Building Company and Thomas B. Bryson of New York, Stephen Pearson Brown, Chief Engineer; Claude T. Wilson, Principal Assistant Engineer; Robert Eldredge, General Superintendent.

CONCRETE POLES USED.

Poles of reinforced concrete for both high and low tension electric current are finding an increasing demand in Germany, and Karl Roessle, in "Beton und Eisen," describes those used for the "Hohenzollern-Sportpalast," skating rink in Berlin. Because of the decay of wooden poles, the high price of iron poles and the constant attention required for maintenance, the management decided to employ reinforced concrete. The simplicity of the system used, the Wolle, made it possible to cast all poles in wooden forms at the site of the work. Both the fabrication and the erection were accomplished without use of machinery, and the cost was about one-half that of iron poles. The poles were lightened by adopting a tapered section, reducing the size from about 1.2 by 1.8 feet at the bottom to .46 by 1 foot at the top, and at equal distances for the greater part of the length, holes were cut through, which not only reduced the weight, but also presented less surface for wind pressure in the direction of the smallest resisting moment.

The height of the poles, which curved at the top, was about 44.3 feet, of which 8.2 feet was in the ground, which brings the arc light 32.8 feet from the

ground surface. Heavy signs, suspended between posts, increased the bending moment at the ground level. Therefore, a flat iron plate of rectangular cross section, about 2 by 3½ feet, was placed on either side between the ground and the pole extending from the surface of the earth downward. The greatest difficulty experienced was in placing the conduits for electric wires. The poles were erected by wooden shear-legs 29.5 feet in length, and, although the total weight of each pole was approximately 9,259 pounds, they were raised without injury when but fourteen days old.

STEAM CURED CONCRETE BUILDING BLOCKS.

I have used steam for curing blocks for three years and I know that steam-cured blocks are better than those that are cured in the open air. In the first place, blocks that are cured outside will get the sun or wind, which is not good for them, and again the man who sprinkles the block is apt to tire and half of the block gets water and the other half gets none, says V. B. Eichenlaub of Erie, Pa.

I have two steam sheds, 60 feet long, 8 feet wide and 6 feet high, made of common hemlock lumber, lined inside with waterproof paper. It is double tracked and will hold six cars on each track. Two men will make six cars or 144 blocks a day. The blocks are taken from the machine and put on cars and run in the steam shed. One track is filled one day, the next track is filled the next day. The first cars put in will be taken out the next morning. That will give the first cars about 48 hours' steam. The steam sheds should never be over 90 degrees; that will give you moist steam and plenty of water, as it drops from the ceiling. When I run out the cars I pile them up and give them one dose of water and pay no more attention to them.

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The Most Economical Sprocket Wheels on the Market

Last several times as long as ordinary cast-iron wheels, and cost but little more

Are accurately fitted to the original "Ewart" chains, of which we are the designers and makers



Life of chain prolonged, because wheels are not rapidly wearing away from the proper pitch diameter

Write for Catalogue

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The economy resulting from the use of these wheels appeals to all who appreciate durability and satisfactory service, and especially to those who wear out machinery rapidly in handling Raw Materials in Cement Mills, Phosphates, Crushed Stone, Ashes and other abrasive materials

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CONCRETE BLOCK FIREPLACE.

A most interesting feature of the prize house given away at the Cement Show in Chicago, in February, 1910, is a concrete block fireplace and mantel, occupying a conspicuous place in the living room. This mantel piece is a splendid illustration of the adaptability of concrete for interior use. It has a handsome and substantial appearance, and is a very superior form of fireplace.

The concrete blocks in the fireplace and mantel were made by the Ideal Concrete Machinery Co., of South Bend, Ind., in their own molds. The facing is composed of one part of Portland cement and two and one-half parts of Feldspar No. 4, while the backing was composed of one part of Portland cement and five parts of pit run gravel, passing a $\frac{1}{4}$ screen. As nearly all of these blocks were of special size, they were made by hand labor. The two ornamental blocks, one on each side of the breast, were made in a gelatin mold. A wooden pattern was made just like the ornament and this was placed in a mold. Hot gelatine was then poured around the pattern and allowed to cool. When cool, this was cut into several pieces and the pattern removed, after which the gelatine parts were replaced in the mold and this was filled with wet concrete. The following day the concrete ornament was taken out of the mold and the mold was again used to make the second ornament. All the granite faces were sprayed with water and scrubbed with a solution of acid and water so as to expose the granite aggregate.

The blocks are all of the very best quality and of the kind that are meeting with increasing popularity year by year.

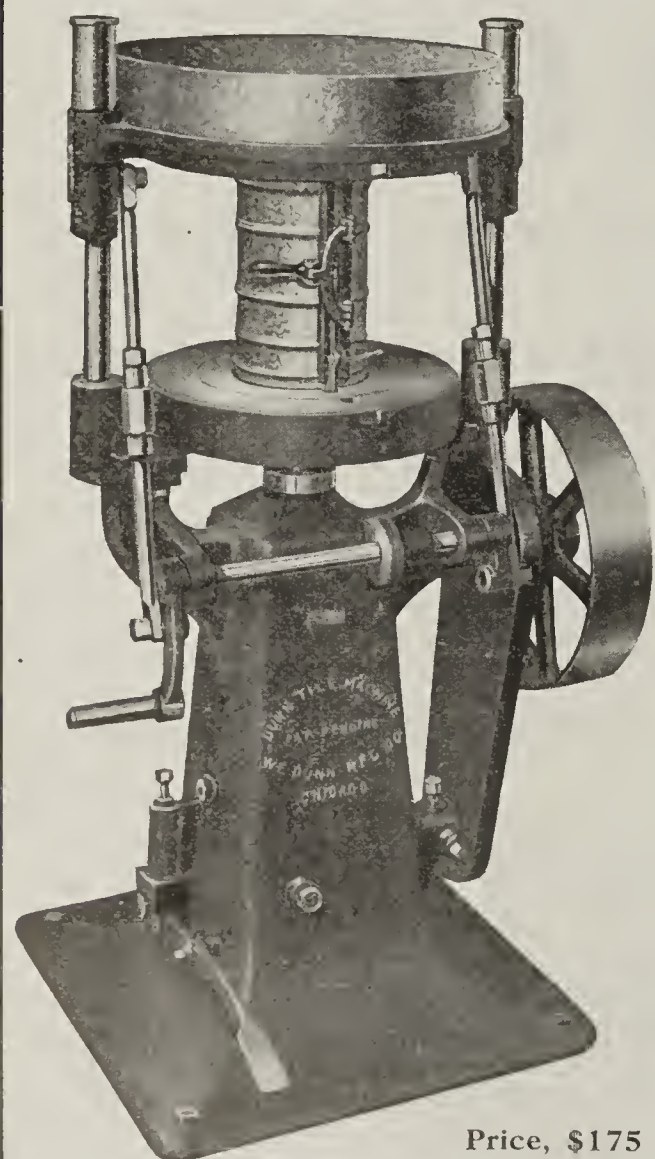
SIDESTEPED INVESTIGATION.

This story from the Tulsa (Okla.) Democrat is of interest as showing the methods of some so-called disinterested investigators of the tile problem:

"B. Brooks, representing the clay pipe trust, who has been in Tulsa several days endeavoring to gather data unfavorable to the cement tile manufactured by the Tulsa Cement Tile Company, has hurriedly left the city and refused to be present at an inspection of clay pipe and concrete pipe that is to be conducted by City Engineer Hughes.

"Brooks, according to G. N. Wright, president of the Tulsa Cement Tile Company, has gone to an abandoned drainage ditch that had been put in by the sewer department as a temporary affair and was made out of pipe that had been condemned by the Tulsa Tile Company itself, and had pictures made which he was prepared to show over the country as illustrating the poor quality of cement tile. He also secured a permit from the city to dig up sewers laid with cement tile in order, as he explained, to ascertain how it withstood wear. When Mr. Wright heard of this he entered a vigorous protest and demanded that if an inspection was to be made that it be conducted by some one who was not committed in advance to finding the cement pipe unsatisfactory. He offered to pay the whole cost of the inspection and said he was anxious that it be thorough as he desired to know himself if cement pipe is all that is claimed for it. He said he expected to put in a large plant if it is all right, but if it isn't all right he wanted to know.

"Upon his recommendation the city commissioners authorized the city engineer to make a thorough in-



Price, \$175

A Little Giant for Strength, Capacity and Durability

Try This Tile Machine In Your Factory 15 Days Free

If it wasn't a good machine we couldn't make such a liberal offer, could we?

Make cement tile. It is a safe, substantial business that will make you from \$5.00 to \$15.00 per day net profit.

This machine makes all sizes of cement tile from 3 to 12 inches. It makes 1,800 to 2,000 tile per day of 10 hours with two men operating.

It is built from the ground up. There are no bolts to work loose and no shaft can get out of line. All working parts are enclosed in the heavy cast iron base, perfectly protected from dust and sand. Even the chain is protected by a solid guard.

Packs the tile hard at the bottom, making them of equal density at both ends, and every tile perfect.

Table of machine 34 inches high. Just the right height for operator.

We ship the machine on 15 days, free trial and if it isn't satisfactory or won't do all we claim for it, then ship it back. That's a safe way for you to buy. We'll take the chances of the machine making good because we know what it will do.

Send for a catalogue

It tells all about this tile machine, besides, block machines, brick machines, porch and chimney molds. Send today while you think of it.

W. E. DUNN MFG. CO. 4139 **FILLMORE STREET CHICAGO**

vestigation of both kinds of pipe and report which would be the most economical and most satisfactory for the city to use. Saturday morning when the city engineer was arranging for the inspection, it was discovered that Brooks had paid his bills at his hotel and quietly departed.

"The clay pipe trust has had agents out over the country scouting for unfavorable reports on the cement tile. Brooks was one of these scouts. When he appeared in Tulsa he represented to the commissioners that he desired to make an entirely unbiased investigation of the two kinds of sewer pipe and on this representation he was permitted to proceed. When the commissioners were informed that he in reality desired to obtain data he could use in condemning cement pipe and that he was in the employ of the trust, they declined to allow him to proceed with his so-called investigation and authorized one themselves.

"Although the commissioners are convinced that Brooks by skipping town has confessed clay pipe is not to be compared with cement tile, they will proceed with the investigation.

"Mr. Wright insists that Brooks never intended to make a fair comparison of clay and cement tile, but was here solely for the purpose of manufacturing any kind of a story that would show up cement pipe in an undesirable light, and thus redound to the benefit of clay pipe."

RUSH WORK ON CONCRETE GRAND STAND.

At the Polo Grounds, the New York National League Ball Park, work is being rushed to complete the new reinforced concrete grand stand and bleachers.

MANITOWOC CEMENT KILNS
DRYERS
COOLERS, ETC.

**Manitowoc
Engineering Works**

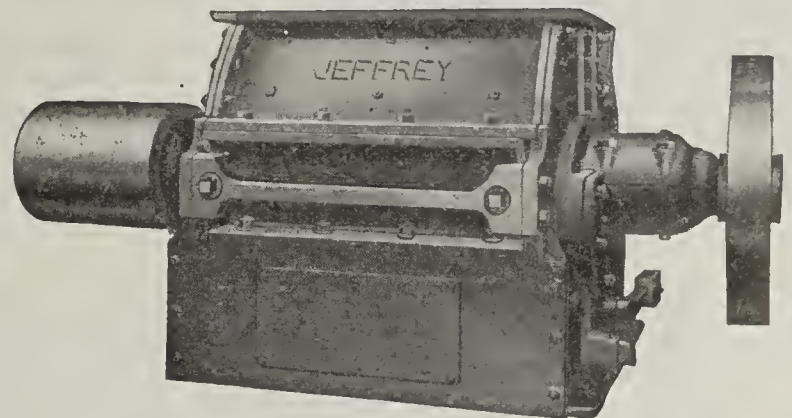
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June 26th an order was issued by George F. Coffin, referee in the bankruptcy case of the Northampton Portland Cement Company for the sale of the property on July 15.

On June 23rd bondholders sold the plant of the Bonneville Portland Cement Company, at Siegfried, which was built by the late A. B. Bonneville, a pioneer in the industry twenty years ago at a cost of \$400,000 and on which there was a bonded indebtedness of \$600,000. It was sold five years ago to a party of Philadelphia politicians, including Senator McNichol, Charles Seger, Israel W. Durham, Senator Penrose and others, but did not pay. The new owner, Frank Tooney, of Philadelphia, paid \$16,500, will dismantle the plant and convert it into junk.



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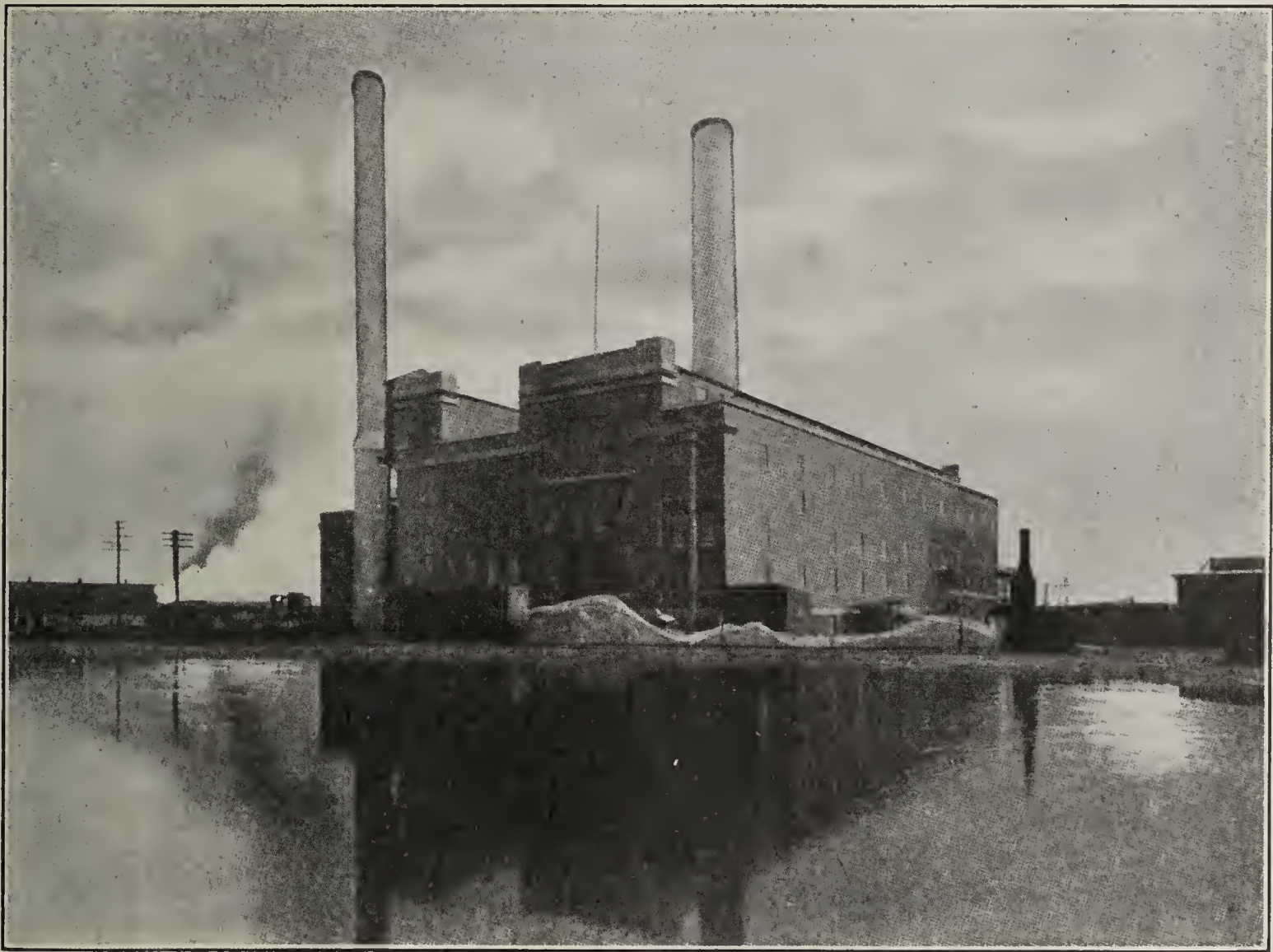
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(PUBLISHED MONTHLY)

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CHICAGO, OCTOBER, 1911

ADVICE TO ENGINEERS.

Of the many worthy publications on engineering issued recently, none has impressed us as favorably as a book published by Waddell & Harrington, Kansas City, Mo., entitled, "Addresses to Engineering Students."

The perusal of the weekly and monthly technical magazines and of the latest books on engineering subjects, through which we keep posted upon everything going on in our special branch of engineering science, is a rather businesslike occupation which, though mostly very interesting, often becomes even monotonous in the face of the frequent repetitions and unessential details worked in in order to make the publications more voluminous.

In the presence of all these matter of fact contributions, it is certainly refreshing to pause an hour now and then and to read one of the entertaining and elevating chapters composing this book.

Though originally intended for engineering students, the scope of the book is much wider. It embraces in the first place advice to be given to young engineers during their college years; it furthermore points out to them how to make the best use of the acquired knowledge and of their talent after having graduated, and consequently contains valuable hints for all of us as long as we are in business.

The book, made up of dozens of chapters contributed by eminent engineers and university professors, reads like a sermon in some places, like a wholesome lecture in others, and affords a pleasant pastime wherever you open it. No matter whether you read the chapter on the "Educational Value of the Technical Press" or the "Hints on the Education of an Engineer" or the "Relation of the Engineer to Society," you will be pleased with its contents, as every page describes some phase in the engineer's life and reminds him of the numerous ways in which he can materially contribute towards improving his condition and position in life.

Most of the contributions owe their origin to solemn occasions, when men at the head of the profession are invited to lecture to large audiences on the methods leading to success in engineering life or on the ways in which an engineer's social and business position can be advanced, and therefore contain practical advice as well as the endeavor to inspire the reader with the ennobling lofty aims of his profession.

Any one would go a long way to be able to listen to one of the speakers and to carry home some useful resolutions. Thanks to the authors' compilation of all these valuable papers we are fortunate enough to read them at our leisure at home one at a time whenever we feel in need of some advice as to how to improve our condition or how to make our services to the profession more efficient.

WATERPROOFING OF CONCRETE.

By Dr. Paul Mecke.

A long time before special compounds were known for waterproofing cement, hydrated lime was used for this purpose. However, the desired result was obtained only imperfectly and only under certain conditions; moreover, it took a longer time for this lime-cement mixture to become impervious to a certain degree, a fact which made the application of it almost impossible, as in practical use water can mostly not be prevented from coming in contact with the concrete during the setting period.

The cause of the admission of water into the interior of concrete is the existence of air spaces, that is to say of pores through which the water is pressed by exterior pressure or by capillary attraction. That such pores cannot possibly be excluded can readily be seen from the fact that cement must be gauged with more water than is able to chemically combine with it. The surplus water evaporates in time and thus causes pores to form. This deliberation shows that an admixture of finely powdered minerals, which is frequently practiced, can never fulfil the purpose for which it is intended, namely filling of the pores or reducing of their diameter to such an extent that water will no longer penetrate.

Modern waterproofing compounds can be divided into two classes, those which waterproof the concrete throughout and those which render only the surface impermeable. The latter have the disadvantage of being applicable only to dry walls, a condition which cannot be fulfilled where water exists; besides, they are unable to withstand water under pressure and can, consequently, be used only in cases in which concrete has to be protected from rain.

Reliable waterproofing compounds belonging to the former class must act partly chemically and partly mechanically. Under conditions obtainable in laboratory experiments, but never in practice, cement, without admixtures, can gradually be made waterproof in mixtures of 1 cement to 3 sand or even 1 cement to 5 sand, namely by subjecting a slab composed of these mortars to a very low pressure in the beginning and by increasing the pressure very slowly. The water percolates in the beginning, but, on its way through the mortar, dissolves some of the ingredients, mainly calcium hydrate, which latter is recarbonated

upon coming in contact with the air and thus made insoluble at the same time closing the pores. An admixture of calcium hydrate, therefore, would merely increase the percentage of soluble ingredients and fill the pores somewhat faster. However, this process goes on too slowly where water under pressure is to be encountered. In the latter case, a real waterproofing compound has to be resorted to.

A genuine waterproofing compound acts by offsetting capillary attraction within the pores, that is to say by, as far as possible, preventing the water from adhering to the walls of the pores. This property of the waterproofing compound is sufficient in the case of lower pressure or humidity; but, where higher pressure prevails, chemical action on the order of the recarbonation of the hydrated lime previously described has to be added. Therefore, a waterproofing compound must, even in the case of high pressure, permit the water to penetrate the concrete only far enough to allow the dissolved ingredients to become again insoluble before they reach the surface of the concrete opposite to the water. This explains the fact, proven by experiment, that the imperviousness increases with the time (independent from the increasing hardening of the cement) by steady filling of the pores with mineral substances. Consequently the action of a reliable waterproofing compound is not of a transitory nature.

The foregoing, furthermore, makes clear that a waterproofing compound, in order to be effective, must be in a fine state of subdivision so that it may be intimately mixed with the cement with the view to not impairing its strength. This object can best be obtained by dissolving the waterproofing compound in the water used for gauging the cement or by keeping it in suspension in the water or by obtaining an emulsion. A good waterproofing compound renders also lean cement mortars and concrete waterproof, whereas an admixture of calcium hydrate is able to render only rich mortars impervious and these even only under proper manipulations, for the pores increase with the increasing percentage of the sand, and the solution of calcium hydrate necessarily passes through the pores so quickly, as capillary attraction is not decreased or offset, that the transformation into carbonate of lime takes place only on the outside after the water carrying the calcium hydrate in solution has passed through the whole thickness of the concrete.

WHITE PORTLAND CEMENT.

The Sandusky Portland Cement Company announces that it has received an order to furnish all the white Portland cement that is to be used in the construction of the Woolworth building in New York City. This building, which is to be fifty-five stories high, will be the tallest in the world. The Sandusky Portland Cement Company is to furnish 10,000 barrels of white Portland cement for the job.

The cement will be turned out at the York, Pa., plant of the company, which factory was built for the special purpose of manufacturing this kind of cement.

Another big order for white Portland cement was that received some time ago, to be used in the construction of the new New York postoffice. The order called for 5,000 barrels.

The company also recently shipped ten carloads of white cement to New South Wales, Australia.

NEW RAILROAD REGULATIONS ON SACKS.

The railroads in territory west of Chicago have taken another step to protect themselves and shippers of returned cement sacks against improper bundling and marking. This question has been the subject of a great deal of study and investigation on the part of the roads for several years, and, with the assistance of the cement manufacturers, uniform rules as to how returned sacks shall be bundled and marked have been put into force throughout the entire country. At the risk of appearing to repeat what has already been said a number of times in this bulletin, we would mention that these rules embody the following requirements:

Each bundle of sacks shall be securely tied with not less than three separate wire ties, or three separate ties of rope, the latter to be at least 3-16 of an inch thick.

Each bundle shall be marked with a linen tag showing the name and address of shipper and consignee, the tag to be securely fastened to the bundle by wire.

Freight must be completely prepaid.

In the western territory alluded to above the railroads' tariffs have contained a provision to the effect that if bundles were not tied and tagged in accordance with the rules, double freight should be charged. Under this ruling, the railroad agent was obliged to accept improperly bundled and tagged shipments, his only recourse being to double the freight charges. It has been found, however, that the double freight charges did not compensate the railroads for the loss and expense that they were still sustaining by reason of defective shipments being broken up and losing their identity in transit. So a movement is now under way to abolish the privilege of shipping improper bundles at the double freight rate and to substitute a rule obliging the railroad agent to refuse to accept a shipment unless it is properly bundled and tagged and the freight prepaid to destination.

At first sight the new regulations that the railroads expect to adopt may appear to be unnecessarily strict, but this is far from being the case. East of Chicago this ruling has been in effect for some time and the application of it has been found to work for the benefit and protection of the shipper. The cement manufacturers throughout the country only buy back returned cement sacks f. o. b. delivered to them, which means that the shipper must make delivery of the sacks to the cement manufacturer at his plant and in good order before he can expect to receive credit for them. This means that, legally, the shipper must stand any loss or damage that the shipment sustains while on its way to destination. Therefore, when bundles are broken open in transit, due to improper bundling, or when insecure tags are torn off and the bundles go astray, the shipper is the one who stands all the loss, in addition to which he stands the expense and annoyance resulting from failure of shipments to get to destination promptly when freight is not prepaid.

There is every prospect that this new rule will go into effect July 1st, and that sack shipments will thereafter be refused by the railroads if they are not bundled, tagged and shipped in accordance with the regulations. Even if the rule should not become effective, every shipper of sacks should make it a point to see personally that his sack shipments are handled in the way that the railroads require. The regulations that the railroads have established are fair and reasonable and should be followed by everyone as a matter of self-protection.

A Scheme for the Rapid Analysis of Cement

Clarence N. Wiley and W. A. Ernst

Chemists who are engaged in the manufacture or testing of Portland cement have long wished that they could obtain a complete analysis of a cement, the composition of which was in question, without proceeding with the tedious and lengthy method generally employed. This method, in order to be accurate, calls for the solution of the cement in hydrochloric acid, evaporation to dryness, followed by a short baking in order to render the silicic acid entirely dehydrated and insoluble. This evaporation must be carried out with more or less care, because if the evaporation is made at too great a temperature or in too hasty a manner, and extreme care is not taken, the gelatinous silicic acid, in being freed from its water, will spatter and danger of loss is incurred. The operation requires at best from three to four hours, and if all of the silicic acid is not dehydrated, a loss is bound to occur through silica passing through the filter.

The old method for the separation of iron and alumina, by means of fusion with potassium acid sulphate, is also a source of annoyance to the busy chemist. Fusion must be carefully watched until the liquid stage has been reached and even then if the heat is not carefully adjusted frothing or boiling over is frequent. To make this fusion requires time and attention taken from other, perhaps more important work. The solution of the cake is again an occasion of delay and the reduction of the iron present, to be properly accomplished, requires several hours and, if the iron is in large quantity, even longer.

The determination for magnesia also consumes much time and it is the general custom to allow the granular crystalline precipitate of magnesium ammonium phosphate to completely subside so that filtration may be speedily accomplished.

A complete analysis of cement, therefore, covers a period of two days' time, although it can be done in the course of one day by careful manipulation. The authors have been searching for some time to find a method whereby accurate results could be obtained in a much shorter time. They had already adopted the schemes for the determination of magnesia and the separation of iron and alumina, which will be described later, but had found no suitable method for the rapid accurate determination of silica.

Some time ago there appeared in *Tonindustrie Zeitung*, 35,265, a method described by G. Hentschel, whereby silica can be accurately separated from cement by means of acetic acid and in a very short time. Here at last appeared the solution of our problem, and upon the first trial of this method we knew that the operation of cement analysis could be accomplished in a few hours' time.

The method described by Hentschel is as follows: "One gram of cement is ground to powder in a porcelain dish; a little water and 10 cc. acetic acid added. The mixture is then heated under constant stirring for about 15-20 minutes, till the cement has settled and no particles are floating around any more. Now more distilled water and as much dilute nitric acid is added as is necessary to keep the iron and the silicates of aluminum in solution. The mixture is heated again for 5 minutes. It is then filtered off with accompanying decantation of the residue silica, washed in hot water and filtered again. If sufficient care is taken, the filtered silica will always be free from iron

and aluminum silicates. After washing the silica is ignited and then weighed. After heating in the water bath, the solution must be treated with nitric acid and not hydrochloric acid, as this would prolong the test. The determination can be made within one and one-quarter hours, whereas any of the other methods take at least three to four hours."

After repeated trials, the authors have decided that there is no difference in the time of operation whether nitric acid or hydrochloric acid be added to the liquid after solution by acetic acid. Also it has been determined that but 5-6 minutes are required for digestion if 0.5 gram of material is used, and the results on the smaller amount are equally accurate.

The entire method for the complete analysis of Portland cement now in use by the writer is as follows: Weigh 0.5 gram of cement into a porcelain casserole, add water and then 10 cc. glacial acetic acid. Stir with a glass rod until all lumps are broken up, then place on the hot plate and digest, stirring from time to time until no particles of cement remain. This requires about 5 minutes, and care should be taken that the contents do not boil over. To this solution add a dilute solution of hydrochloric acid until the reddish color is dissipated. Filter and wash thoroughly with hot water, ignite the precipitate, blast for a few minutes, cool and weigh. After a little experience this operation can be completed in 30 minutes.

The filtrate from the silica is now made up to 200 cc. in a graduated flask and aliquot portions separated. To the first is added a few drops of nitric acid, and then ammonia until the iron and alumina are precipitated as hydrates. Set the solution aside for a few minutes on the hot plate until subsidence takes place, filter, wash, ignite and weigh as oxides. Alumina and iron are separated in the second portion by means of the Zimmermann-Reinhardt method. Heat the solution to boiling, reduce the ferric chlorid by adding drop by drop a solution of stannous chlorid (a) until the solution becomes colorless. Cool, make up to 300 cc., add 25 cc. manganese sulphate solution (b). Stir vigorously add 10 cc. mercury chloride (saturated solution) and titrate the solution at once with potassium permanganate.

The filtrate from the first portion is now made up to about 400 cc., the lime precipitated as calcium oxalate filtered, washed and titrated with potassium permanganate in the usual manner.

The filtrate from the lime is boiled down in an evaporating dish to about 200 cc., acidified with hydrochloric acid and washed into an Erlenmeyer flask. Add sodium ammonium phosphate solution and about 5 cc. ammonia and cool in running water, shaking vigorously, until the precipitate begins to form. Then add about 15 cc. of ammonia and shake for about 10 minutes. Allow the precipitate to settle for about 5 minutes and filter. Wash with the usual solution, ignite and weigh as magnesium pyro-phosphate.

(a) Stannous chlorid solution, 25 grams stannous chloride are dissolved in 100 cc. concentrated hydrochloric acid and diluted with water to 1 liter.

(b) Manganese sulphate solution, 67 grams crystalline manganese sulphate are dissolved in 500-600 cc. water, 138 cc. phosphoric acid (sp. gr. 1.70) and 130 cc. concentrated sulphuric acid (sp. gr. 1.82) are added and the mixture diluted to 1 liter.

While the above procedure has been carried on, another sample has been started for the determination of sulphuric anhydride. In this case take 1 grain of cement, digest with acetic acid as before and add diluted hydrochloric acid before filtering. The filtrate is heated to boiling and a few cc. of alcohol are added. Barium sulphate is preprecipitated by means of barium chloride solution and the beaker stood on the hot plate for one-half hour, at the end of which time all of the barium sulphate will have subsided and filtration can be speedily accomplished.

From a large number of determinations we have found that it requires from two to two and one-half hours to make a complete analysis of cement and our results have agreed very closely with those obtained by means of the usual method. These results are sufficiently accurate for control work and the great saving in time makes this short method of great value. In the routine of the cement works' laboratory, the daily analysis of the finished cement becomes very monotonous because of the fact that it may be considered "post mortem" work, by which is meant that the composition of the cement can not now be altered. Where large clinker storages are in use, the clinker may not be ground for several weeks after it is discharged from the kilns. It is thus seen that analysis of the finished cement is of very little value except for purpose of record and comparison with the physical tests.

Following are given several results of analyses made by both methods:

	Regular.			Acetic Acid		
	(1)	(2)	(3)	(1)	(2)	(3)
Silica	21.42	22.74	21.50	21.34	22.94	21.40
Alumina	7.38	7.24	7.66	7.34	6.98	7.76
Iron Oxide.	2.60	2.72	2.84	2.60	2.72	2.84
Calcium						
Oxide	62.40	61.46	62.18	62.40	61.85	62.33
Magnesium						
Oxide	2.41	2.26	2.51	2.52	2.26	2.45
Sulphuric						
Acid	1.33	1.45	1.27	1.34	1.45	1.27
Loss on						
Ignition.	1.54	1.38	1.14	1.54	1.38	1.14

Nos. 1 and 3 were completed in 2½ hours and in No. 2 the silica, alumina, iron oxide and calcium oxide results were obtained in 45 minutes after the sample was weighed. We have obtained results of complete analyses which have checked closer than the above, but these are given as they represent the average of our experience. Determinations of silica completed in 20 minutes check as follows with silica evaporations:

(1)	Regular		(1)	Acetic Acid.	
	(2)	(3)		(2)	(3)
21.54	22.94	21.56	21.50	23.00	21.65

Efforts have been made to apply this acetic acid scheme for the decomposition of raw material, shale and clay and limestone, but so far have not been successful. Evaporation after fusion must be practiced to render the silica insoluble, but it is our hope to find a method whereby this determination may be considerably shortened.

The Richmond Cement Culvert Company, Richmond, Mich., which operates plants at Richmond and Caro, is making arrangements to operate a third plant at Howell.

SAND-LIME BRICK PLANT IN NORTHWEST.

The Northwest Brick & Lime Company, 436-7 Globe building, Seattle, is well along with the reconstruction of its plant on Whidby Island, which was destroyed by fire about a year ago. Work has progressed to the extent that operations will be started within 50 or 60 days. All the outbuildings are completed and are of a permanent nature. The boiler and engine house are being constructed of brick manufactured by the company. The other buildings are of mill construction. The company has a direct sewer route into the Sound and has its own water connections.

The capacity of the plant is being doubled, which will mean 40,000 face brick for every twenty-four-hour run. Many shapes and colors of brick will be made, the wishes of customers being kept in mind. All requirements as to price and quality will be met.

In reconstructing the plant, all the latest improvements in machinery have been taken into account, and every feature will be strictly up to date.

The company has an unlimited supply of raw material. One of the finest sand banks in the United States supplies a sharp, clean, clear silica sand. This sand in its natural condition is of about the proper consistency for brick making purposes. The source of lime supply is a half section of land in Snohomish county, near Granite Falls. The holdings at the plant aggregate 73 acres of land, with 1,500 feet of water front. It is estimated that the supply of raw material from the two sources mentioned will run the company for a period of fifty years. Contracts have also been closed for the purchase of large quantities of limestone in the San Juan Islands.

The market for the product includes Oregon, Washington and British Columbia. So great are the demands of this territory that it is not likely the company will undertake to extend its field of operations in the near future.

The officers of the company are: A. E. Whetstone, president and general manager; G. S. Hastings, secretary, and A. G. Keene, treasurer.

NEW LIME COMPANY.

Manufacturing annually a product worth approximately \$100,000, the International Lime Company is the latest addition to Washington's larger factories. The new plant is situated in the foothills of the Cascades, near Mount Baker. Seattle is headquarters for the company. Two hundred and fifty thousand dollars is said to be invested in the new enterprise.

Jesse Frye, of Seattle, is president of the International Lime Company, Stuart Mannell, of Victoria, B. C., is manager, and J. J. Maney, a well-known Seattle contractor and railroad builder, is consulting engineer. Mr. Frye and Mr. Maney gave following statement for publication:

"This plant will be the first of its kind on the Pacific Coast to produce hydrated lime, which engineers and architects now recognize and which they specify to the extent of 15 per cent in all mortar mixtures for brick, stone or stuckover." Mr. Maney said: "The product is also of the greatest value in waterproofing and fireproofing construction. The by-products, including lime fertilizer, will be absorbed by the markets of the Puget Sound district as rapidly as they are made. The lime fertilizer has been demonstrated by the United States department of agriculture as particularly valuable to the soils of the farming and dairying sections of western Washington."

Manufacture and Use of Concrete Blocks

Principles Governing the Manufacture and Curing of Concrete Blocks and Their Adaptability to Building Construction.

By Robert F. Havlik, M. E.

Five years ago concrete blocks were used in cheap buildings only, in foundations and underground. Only cut stone was considered for work where a cut stone effect was desired. A gradual change has taken place, however, and the moulded concrete block is now being used in some of the finest buildings. Cut stone is no longer as popular as it was then—not because it is not as good as the moulded concrete block, but because the block can now be made as good as cut stone at a much lower cost; and since cost is always a prime consideration when the quality is the same, the moulded concrete block is destined to play an important part in the building operations of the future. The best testimony we have of this is in the magnificent buildings of the Barber Estate, Barberton, Ohio. These are being built of moulded concrete blocks made in standard machines and special wood and gelatine moulds. When such men as Mr. Barber, who want a beautiful effect regardless of price, select moulded concrete blocks in place of all other materials, there must be a great value in properly made concrete blocks.

The speaker is fully aware of the fact that an immense amount of inferior work has been done in concrete blocks; but mistakes have been made in every new industry, and it was but natural that mistakes should be made in the concrete block industry. But we have passed the mere experimental stage of this industry, and concrete blocks are now a staple building material; and if we continue to improve them in the future as we have done in the last few years, they will soon be in greater demand than any other one building material. Concrete blocks have everything in their favor. They make a house that is cool in summer and warm in winter; their strength increases with age, whereas nearly all other building materials deteriorate with age; they can be made waterproof; and last, but not least, homes built of blocks cost less in the last analysis than frame buildings, because they require no repairs. But for this fact, many a building now being put up of concrete blocks would be built of frame, on account of the prohibitive cost of brick or stone. Thus the concrete block is improving the building construction of today, both in beauty and in permanency.

We can improve this industry best by paying more attention to the selection of the materials used and the methods employed in the manufacture of the blocks, and to placing on the market the best product we can make.

Cement—The cement should be a Portland cement that will pass standard specifications.

Aggregates—The most common aggregates used are sand and gravel, although crushed stone is sometimes used in place of the former. There is considerable objection, however, to crushed stone on account of the crusher dust that is always present and clings to the stone particles and prevents the cement from properly bonding with same. It has been my experience that gravel and sand produce a denser and better looking concrete. In many localities, however, sand and gravel cannot be had except at prohibitive prices, whereas crushed stone may be very plentiful.

In such cases there is no recourse except to use this material. Whatever the materials, the finer, which is usually sand, should be well graded from $\frac{1}{4}$ inch to $\frac{1}{50}$ or $\frac{1}{100}$ inch. The coarse material should be well graded from $\frac{1}{4}$ to $\frac{3}{4}$ inch, not to exceed 1 inch. The largest aggregate should never be larger than half the thickness of the thinnest wall of the block. Where a pit run of sand and gravel is used, the material should range in size from $\frac{1}{100}$ inch to $\frac{3}{4}$ inch. Both fine and coarse aggregate should be free from clay, dirt, or fine dust, as these but tend to decrease the strength of the block. The water should be free from alkalis.

Proportioning—The next important consideration is that of proportion. There are three principal methods in vogue for determining the proper proportions, the "void" method, proportioning by trial mixtures, and proportioning by a study of the mechanical analysis of the various aggregates. The first method is universally acknowledged to be little better than a guess.

For any given materials which are to be used in their natural state, the second method of proportioning by trial mixtures will be found very satisfactory, but will not show what other changes in the sizes of the aggregate could be made. The procedure in this method is very simple. First, get a good scale and rigid cylinder, say a piece of 8-inch or 10-inch pipe, 12 inches long or so. Weigh out and mix together carefully any arbitrary amounts of the cement, sand, and gravel to be used, and make the consistency the same as that of the concrete to be used in the blocks. Place this mixture in the pipe, tamping same very carefully in thin layers. When it is in place note the height of same in the pipe. Then weigh out the same amount of cement as before, and the same total weight of sand and gravel, but vary the relative amounts, and repeat the operation, using the same consistency as before. Note the height this mixture occupies in the pipe. That mixture which takes up the least space in the pipe is the best for those materials as they are.

The third method, while a little more difficult for the beginner, when once understood, proves to be the simplest of the three. It permits of the immediate determination of the best combinations of raw materials in their natural state, and also how they can be improved upon by adding or screening out certain size aggregates. In 1901, Mr. W. B. Fuller made an extensive series of experiments on the comparative strengths of different proportions of concrete aggregates. All the aggregates used were screened through various sized screens after having been carefully mixed; and the percentages by weight of the materials passing screens of certain meshes were carefully recorded and plotted to curves with the distances on the vertical ordinates representing the percentage by weight passed through screens whose mesh is represented by the distances along the horizontal lines or ordinates. He found that for any given amount of cement the strongest concrete was produced from that combination of aggregates whose mechanical analysis plotted to a curve as above, formed a parabola passing through the zero ordinates and the intersection of the diameter representing the largest stone with the

100 per cent ordinate. This is discussed in detail in a special chapter by Mr. Fuller, in Thompson and Taylor's treatise on "Concrete, Plain and Reinforced." The percentage by weight of the aggregate smaller than a given size can be easily calculated by the formula for the parabola, in which P =per cent of mixture smaller than any given diameter; d =any given diameter; and D =largest diameter of stone.

$$d \frac{P^2 D}{10,000}; \text{ or, } P=100\sqrt{\frac{d}{D}}$$

Table I

This table shows the percentage by weight of any size aggregate required for an ideal mixture, the largest aggregate of which corresponds with one of the sizes given below. For example, if the largest stone is 1" in diam., the % of each of the other sizes is found in column 3. The material smaller than .015" includes the cement. This data is figured by the formula $P=100\sqrt{\frac{d}{D}}$ as explained above.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Diameter of Stone in Inches	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.	% Smaller than Diameter to Left	% between Dia. to Left and Next Larger Dia.
1.00	100.0	0.0	...	...	...	...	...	...	...	...	...	...	...	...	...	...
.75	86.5	13.5	100.0	...	...	...	...	...	...	...	...	...	...	...	...	...
.50	70.6	15.9	81.6	18.4	100.0	...	...	...	...	...	...	...	...	...	...	...
.30	54.7	15.9	63.3	18.3	77.5	22.5	100.0	...	...	...	...	...	...	...	...	...
.25	49.9	4.8	57.7	5.6	70.6	6.9	91.4	8.6	100.0	...	...	...	...	...	...	...
.20	44.7	5.2	51.6	6.1	63.3	7.3	81.6	9.8	89.5	10.5	100.0	...	...	...	...	...
.15	38.7	6.0	44.7	6.9	54.8	8.5	70.6	11.0	77.4	12.1	86.5	13.5	100.0	...	...	...
.10	31.6	7.1	36.5	8.2	44.7	10.1	57.7	12.9	63.2	14.2	70.6	15.9	81.6	18.4	100.0	...
.05	22.3	9.3	25.8	10.7	31.6	13.1	40.8	16.9	44.7	18.5	50.0	20.6	57.8	23.9	70.6	29.4
.02	14.1	8.2	16.4	9.4	20.0	11.6	25.8	15.0	28.3	16.4	31.6	18.4	36.5	21.2	45.7	24.9
.015	12.2	1.9	14.2	2.2	17.6	2.4	22.3	3.5	24.5	3.8	27.4	4.2	31.6	4.9	38.7	7.0
Smaller than .015	...	12.2	...	14.2	...	17.6	...	22.3	...	24.5	...	27.4	...	31.6	...	38.7
Total	...	100.0	...	100.0	...	100.0	...	100.0	...	100.0	...	100.0	...	100.0	...	100.0

From this it will be seen that the per cent of aggregate smaller than a given diameter, say $\frac{1}{2}$ -inch, and larger than a second diameter, say $\frac{1}{4}$ -inch, is obtained by subtracting the percentage smaller than $\frac{1}{2}$ -inch. Table I is figured out on this basis, and shows the percentage of the various sizes for any given mixture up to 1 inch. Any block maker can screen out a sample of his aggregate through standard screens, and carefully determine the percentages of various sized grains present, and compare these with the theoretical percentages; and if he finds that he has too much coarse material, he can screen out his coarse aggregate and recombine it with the fine in the proper proportions to correspond with the parabolic curve. He can do likewise if he has too much of the fine. The process is called "rectifying" the aggregates. I am afraid that some are of the opinion that if an aggregate is graded to the parabolic curve, it will produce the strongest concrete with say 12 per cent cement, and no stronger if 20 per cent cement be used. This is not true, for the strength will be increased with the increased amount of cement; but for any given amount of cement, the strongest concrete will be from that aggregate whose mechanical analysis curve conforms very closely to a parabola. This probably holds true for concrete whose largest stone is $\frac{1}{2}$ inch in diameter or larger. For mortar below number five mesh, I think such an aggregate would have too much fine material. I have found the best result with a mixture of very coarse sand and a sand which is quite fine. (See Table I.)

Mixing.—The selection of the aggregates and the proportioning properly taken care of, the next important consideration is that of properly mixing the concrete. The superiority of machine mixing over hand is an accepted fact, and needs no argument. Mixers should be used by all means, and none but power mixers. Hand mixers are man-killers, as anyone will testify who has used one. In choosing a mixer for

concrete block work, great care should be taken that it will mix semi-wet concrete, and will handle either dry or damp materials. Every mixer will not do this, neither will every mixer that is satisfactory for a very wet concrete prove equally so for concrete used in blocks. It is an easy matter to mix concrete of the consistency commonly used in monolithic work, but that used in blocks, being drier, is far more difficult to mix.

Facing.—As nearly all concrete blocks are faced, considerable attention should be given this feature in their manufacture. Most blocks are sold on their ap-

pearance; so it is essential that the face be very hard, and all corners and edges solid. For this reason it is necessary to use richer proportions for the facing than are used in the backing of the blocks. The usual proportions vary from $1\frac{1}{2}$ to 3 parts of aggregate to 1 part of cement. When ordinary sand is used, it should be graded from $\frac{1}{8}$ inch down to No. 50 mesh, with no material smaller than No. 100 mesh. The proportions can be as low as 1 part of cement to 3 parts of sand; but in white facing the proportions must be richer, as all available white aggregates are either all one size, as in the case of white sand, or contain too much fine material, as is the case in most crushed white marble. With some white sand and crushed white marble, I obtained very satisfactory results with 3 parts white cement, 2 parts crushed marble- and 4 part white sand.

In colored facing, none but mineral colors should be used. With proper materials and care, it is possible to use as high as 50 per cent coloring in the proportions of 1 part cement, $\frac{1}{2}$ part color, and 1 part aggregate. Dark, deep shades cannot be obtained except with a large percentage of coloring. Colored blocks and brick can be brought to a high polish by grinding. This process exposes the aggregate and produces a very attractive appearance.

A recent innovation is that of the granite facing. This becoming very popular, and is being used in large cities for public buildings for which the ordinary block would not be considered under any circumstances. The best proportions found for granite facing are 1 part of cement to $2\frac{1}{2}$ parts of granite. The granite should pass a $1\frac{1}{8}$ -inch screen, and be graded to about $1/32$ -inch. These four facings comprise the principal facings used.

Processes of Manufacture.—A few years ago a subject of considerable discussion amongst machine manufacturers, was that of processes of making blocks. Each claimed that his was the only machine in which

a wet block could be made, and that no other was suitable for that purpose. The facts of the case are that as wet a block can be made on one machine as on any other. I find that the limit is reached when the concrete is too wet to bear up its own weight. By this, I mean that beyond a certain consistency the block will settle, and, instead of being $7\frac{3}{4}$ inches high, it may be $7\frac{1}{4}$ inches in height. This fact, then, determines the maximum moisture that can be used in concrete for machine-made products, and will be the same for all makes of machines. It is evident, therefore, that there are but two processes for making concrete products—the poured or cast process, and the moulded or so-called dry process.

In the poured process, the concrete is of such consistency that it can be poured into moulds, which may be of sand, iron, plaster of paris, or gelatine. In this process, the concrete is made as wet as is possible to still permit of moulding. It is then tamped or pressed into moulds, and usually removed immediately. The mould is thus used over and over again. This reduces the cost of the block to a minimum, and enables the block manufacturer to compete with other building materials. Moulded concrete is now being made as good as cut stone. This fact, combined with low cost, is bringing the concrete block to the front as one of the best building materials of the day.

There has been considerable discussion as to the proper amount of water to use in concrete blocks. Most blocks are used when they are about 28 days old; so it is of the greatest importance to have the blocks as strong as possible at this age. Therefore the consistency producing the strongest blocks at 28 days is the best. Actual experiments show that blocks which show the highest crushing strength at 28 days are those in which so much water has been used that it will flush to the surface when a pile of concrete is troweled with a steel trowel or shovel 2 or 3 times. This amounts to from 8 to 10 or 11 per cent of the total weight of the dry materials. Concrete of this consistency can be used in any block machine. When made wetter, the concrete settles and is not so strong. Concrete of this consistency is being used by the largest block plants of the day.

Waterproofing.—Many claim that the block made by the wet process is more waterproofed; but I have seen blocks made wet in the moulded process which were so waterproof that water would stand on same for a considerable time before being absorbed. Neither process will make concrete absolutely waterproof or nearly so. There are a large number of people who claim that a block with low absorption is all that is needed for practical purposes. This is true to a certain extent; but we must not forget that the average builder who is putting up a fine residence will not consider concrete blocks unless the manufacturer thereof will guarantee them to be absolutely waterproof, or very nearly so, absorbing say not over $\frac{1}{2}$ per cent of moisture. I have done considerable experimenting, trying to produce such blocks without the use of waterproofing, but have failed to do so. I do not think that it is possible to reduce the absorption below 3 per cent without the use of waterproofing. By the use of a waterproofing, I have reduced it to $\frac{27}{100}$ of 1 per cent, and I think that this absorption was merely due to the surface water on the specimen so that the block itself probably absorbed no water whatever.

It is to be admitted that with proper care and graded materials, concrete blocks can be made reasonably waterproof, but I contend that they are not waterproof enough, in that they retain moisture too

long. We are all familiar with the looks of the average concrete block house after a rainstorm. It usually remains dark and damp looking for two or three days, while one that is waterproof dries off in a few hours. Any man would prefer to live in a house that looked as dry a few hours after a rainstorm as before, rather than live in a building that remained a dull slate color for several days; so we should endeavor to turn out blocks that will give these results.

As long as blocks cannot be made as waterproof as this without a waterproofing, I will favor the use of proper waterproofing. I know well enough that a great number of waterproofings do not produce waterproof concrete, but there are also a number that do.

In testing a waterproofing, full-sized blocks should be made with same. Only such will be a reliable guide. Tests on small cubes are worthless, as such specimens cannot be tamped nearly as thoroughly as a full-sized block, and consequently will not be as dense and waterproof. I have often noticed that waterproofing is confused with permeability. A block may be waterproof, and yet be very permeable, and vice versa. Waterproofing refers to the per cent of water absorbed by a dry specimen compared to the dry weight of same; whereas permeability refers to the amount of water that will pass through the same specimen in a given time, when placed under a pressure of water. It is evident that the concrete block used above grade need not be impermeable, but should be waterproof. A water proofing may not produce an impermeable block, and yet make a waterproof one. In making white-face concrete blocks, it is absolutely necessary to use waterproofing, as the white aggregates that are most common consist of white sand, which is very fine, and crushed marble or stone, none of which will produce waterproof concrete, the first because it is uniform in size, and the second because it has too much flour.

Even assuming that concrete can be made waterproof with proper materials, the average man cannot get these, and must make use of what he has; so it seems to me that the sooner the use of a good waterproofing becomes general, the sooner will concrete building blocks be used to a greater extent, and the sooner they will overcome the objections of their present severest critics.

Curing.—When the question of aggregates, proportions and processes of manufacture and waterproofing are settled, the next important consideration is that of curing the product. This feature is oftentimes neglected—more than any other. The usual procedure is to sprinkle the blocks with water as soon as there is no danger of washing them away. When this is done, the blocks should be kept moist constantly for a period of at least two weeks, but preferably four weeks. The temperature should register 60 degrees F., or more, and in no case should be allowed to fall below the freezing point. There is no danger in keeping it too high, provided the blocks are kept wet constantly. If they are allowed to dry out, the hardening process is hindered. For this reason, it is customary to keep the blocks under roof for three or four days at least, as it is much easier to keep them moistened under roof than outdoors. This method is extremely simple—so much so that it is surprising how few really apply it fully. Many are doubtless misled by the fact that blocks which are allowed to set until they show signs of drying out, seem harder than those that were sprinkled as soon as they could stand the water. This is true at first; but after a few weeks, the second block will be firmer than the first, and have clean, hard, sharp-cut edges.

It is conceded by all who are familiar with the hardening of Portland cement, that it requires both heat and water to properly harden same. It is at once apparent that the ideal method of curing must, therefore, combine both of these features. The only thing that fulfils these conditions is in an atmosphere of steam. We find many successful exhaust steam curing plants to-day, but in nearly all of these the temperature is kept below 150 degrees F.

Some five years ago, together with Mr. R. J. Wig, after having given this subject careful study, I felt confident that high-pressure saturated steam, which is also at a high temperature, would give the best results. If exhaust steam accelerates the hardening of the cement, it is but a step further to assume that high-pressure steam will do so even more rapidly. We put this theory to a thorough test, and investigated both the effect on the crushing strength of concrete of variations in the steam pressure, and also in

An ordinary block made of 1 part cement and 4 parts sand will crush at about 1,800 lbs. at six months; whereas the same concrete when cured in high-pressure steam will crush as high as 4,900 lbs. per square inch, thus showing over twice the strength. A 1:8 mixture, cured in high-pressure steam, crushes as high as 2,100 lbs. per square inch—practically as high as the 1:4 air-cured concrete at six months. Since nearly all blocks are used inside of 28 days, we are concerned with their strength at this age. Most building ordinances require a crushing strength of 1,500 lbs. per square inch of net area of the blocks. If a 1:8 high-pressure steam-cured block will crush at 2,100 lbs., it stands to reason that the block maker need not use a 1:4 mixture as he must use in the air-cured blocks. He will therefore save about half the cement.

Tables II, III, IV, and V, and the curves drawn from same (Figs. 1 and 2), show the increase in

Table II

This table shows the effect of the duration of steam treatment on the crushing strength of concrete. Proportions of the concrete are: 1 part cement, 3 parts sand, 4½ parts gravel.

Curing Treatment.	Crushing strength in lbs. per sq. in. at	
	2 and 3 days.	7 days.
Not steam-cured, but sprinkled for 1 week.....		379
Steam-cured at 2½ lbs. steam pressure for 3 hrs.....	334	341
“ “ at 2½ “ “ “ “ 6 “	427	484
“ “ at 2½ “ “ “ “ 12 “	517	750
“ “ at 2½ “ “ “ “ 24 “	627	660
“ “ at 2½ “ “ “ “ 72 “	1,095	1,167

Table III

This table shows that the crushing strength obtained by steam curing is permanent. Proportions: 1 part cement, 3 parts sand, 4½ parts gravel.

Curing Treatment.	Crushing strength in lbs. per sq. in. at			
	2 and 3 days	7 days	28 days	3 mos.
Not steam-cured, but sprinkled for 1 week.....		379	1,068	1,426
Steam-cured at 2½ lbs. for 24 hrs.	627	660	1,382	1,488
“ “ at 2½ “ “ 72 “	1,095	1,167	1,270	1,522

Table IV

This table shows the increase in crushing strength of concrete caused by the increase of steam in which same is cured. Proportions: 1 part cement to 4 parts sand.

	Steam-cured at		
	2 lbs. for 24 hrs.	10 lbs. for 24 hrs.	20 lbs. for 24 hrs.
Crushing strength in lbs. per sq. in. at 2 days.....	1,815	1,800	2,184
	Steam-cured at		
	40 lbs. for 24 hrs.	80 lbs. for 24 hrs.	80 lbs. for 12 hrs.
Crushing strength in lbs. per sq. in. at 2 days.....	3,396	4,520	2,540

Table V

Proportions: 1 part Portland Cement to 4 parts sand:

Crushing strength in lbs. per sq. in.....	Age when tested,		
	28 days	3 mos.	6 mos.
(All these specimens were made same as those given in Table IV., but were cured by sprinkling instead of steaming.)	1,854	2,286	2,343

duration of the steam treatment. We found that the crushing strength was increased directly with the duration of the steam treatment, and also directly with the increase in the steam pressure. Concrete blocks cured in high-pressure steam will be doubled in strength over those cured by sprinkling. This means that in order to get the same strength in the block cured in high-pressure steam, only half the cement need be used. This probably holds true up to the point where the concrete would have so little strength when green, on account of lack of cement, that it would crumble under its own weight. I do know for a certainty that blocks can be made of 1 part cement to 8 parts of coarse sand, which, when cured under high-pressure steam, will crush at over 2,000 lbs. per square inch of area.

A second advantage of high-pressure steam curing is that blocks so cured are ready for the market in two days. A third advantage is that rush orders can be filled as rapidly as the blocks can be made and without danger of breaking the edges of the blocks, which happens so often in handling them when they are but a few days old and cured by sprinkling. Moreover, a very important advantage is that blocks faced with white aggregate and any ordinary gray cement, when so cured, will be practically as white as white-face blocks.

strength caused by an increase in the duration of steam treatment and in steam pressure.

Strength of Concrete Blocks.—The use of concrete has been restricted to a large extent in large cities, on account of the fact that many city ordinances limit the use of 8-inch blocks to buildings of but one story in height. This is probably due to the fact that the concrete block is a comparatively new building material, and the average city authorities do not know much about the strength of same; and in order properly to protect their citizens against any inferior and untried building materials, they adopt measures which seem very harsh to those who are in a position to know from experience about the strength of this splendid building material.

There is no reason why concrete blocks should not be just as strong as the concrete used in any monolithic work, and yet we hear very little about the danger of monolithic concrete collapsing. Reinforced concrete is used to-day in skyscrapers and all important buildings, for which purpose it has proved itself to be without a peer. The concrete building block is merely one peculiar form of this material; so in this respect it is really a tried and proven material. In some cities where this question has been investigated, ordinances have been adopted requiring a crushing strength at 28 days of 1,000 lbs. per square inch of

cross-sectional area of the block, as it is used in the building. Assuming a factor of safety of 5, which is greater than that used in steel construction, and which is an average used in other work, the allowable stress will be 200 lbs. per square inch of gross cross-sectional area. The distance of outside bearing walls of an average dwelling will not be over 25 feet, nor will it be greater than this in the average store building. If the distance is any greater, then supporting pillars will be found between the bearing walls.

As an example, let us suppose that the distance between outside bearing walls is 25 feet; and that the total floor load, including the live load and the weight of the floor, is 110 lbs. per square foot; and that the roof load, including the weight of the roof, snow, and wind loads, is 57 lbs. per square foot. These buildings are probably higher than what is found in the average building. One 8 by 8 by 16-inch block weighs about 50 lbs., or 38 lbs. per linear foot. Per square foot of wall the weight of the wall will run about 57 lbs.; therefore the wall weight per story per linear foot of wall will be 12×57 , or 684 lbs.

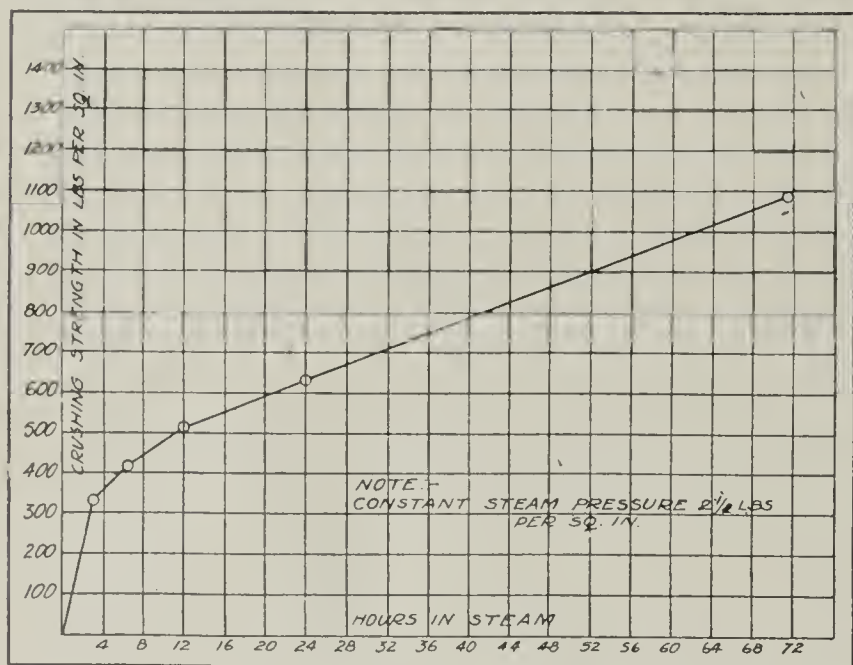


Fig. 1. Curve Showing Increase in Crushing Strength Due to Increase in Duration of Steam Treatment.

For the sake of simplicity, let us consider a strip between two such bearing walls, one foot long and 25 wide, or an area of 25 square feet. The floor loads, etc., will be carried by one foot of each side wall. The floor load per story per linear foot of the two side walls is 25×110 lbs., or 2,750 lbs. The floor load per story per foot of each side wall is half this amount, or 1,375 lbs. The weight of the wall per linear foot of each side wall is 684 lbs, making a total load per foot of each side wall of 2,059 lbs. per story. An 8 by 8 by 16-inch block is 128 square inches in cross-sectional area. Assuming a safe loading of 200 lbs. per square inch, and a factor of safety of 5, the allowable load on one 8 by 8 by 16-inch block will be 25,600 lbs. Per foot of wall, this amounts to 19,200 lbs. This would allow $9 \frac{1}{3}$ twelve-foot stories to be carried by an 8-inch concrete block wall, loaded as above.

It must also be remembered that a concrete block crushing at 1,000 lbs. per square in. at 28 days will probably have a crushing strength of 1,200 lbs. per square in. at 6 months, so that the factor of safety at 6 months will be 6 instead of 5. In view of these facts, it is hard to understand why any city authorities should limit the use of an 8-inch concrete block to one-story buildings only. They should at least be allowed in two-story buildings; and, if necessary, the basement wall in such buildings could be made of 10-

inch blocks. On this basis the actual factor of safety would be 4×5 , or 20, instead of an apparent value of 5.

It is true that some portions of a building will be loaded more heavily than I figured the above, on account of openings in the wall; but the openings are not likely to run over 25 per cent to 33 per cent of the wall area; so the actual factor of safety in any part of the building is likely to be at least 12 where it is allowable to use an 8-inch wall for two stories. In steel work a safety factor of more than 4 is seldom required; so it certainly seems to me that any city authorities would be on the safe side if they allowed the use of 8-inch blocks in two-story buildings, for they can safely figure that the actual safety factor in such cases will be 12, and this will continue to increase, for the concrete will increase in strength the older it gets.

We should not feel that city authorities discriminate against the use of concrete blocks, but rather that the associations of cement users are at fault in not paying more attention to the drawing-up of proper ordinances which can be presented to the various city authorities; and I heartily recommend, if this Association has not already done so, that it take steps to draw up the proper ordinances that will be fair both to the block manufacturer and user thereof, and figure the allowable thickness of walls on a basis of the crushing strength of the blocks, and also limit the maximum loading to which any part of the wall may be subjected. Such ordinances should cover the method of manufacture as well.

It will be found that no ordinances can cover all buildings, especially factories and warehouses. In such cases, the size of the pilasters and bearing walls must be figured according to the actual load to be carried by the same.

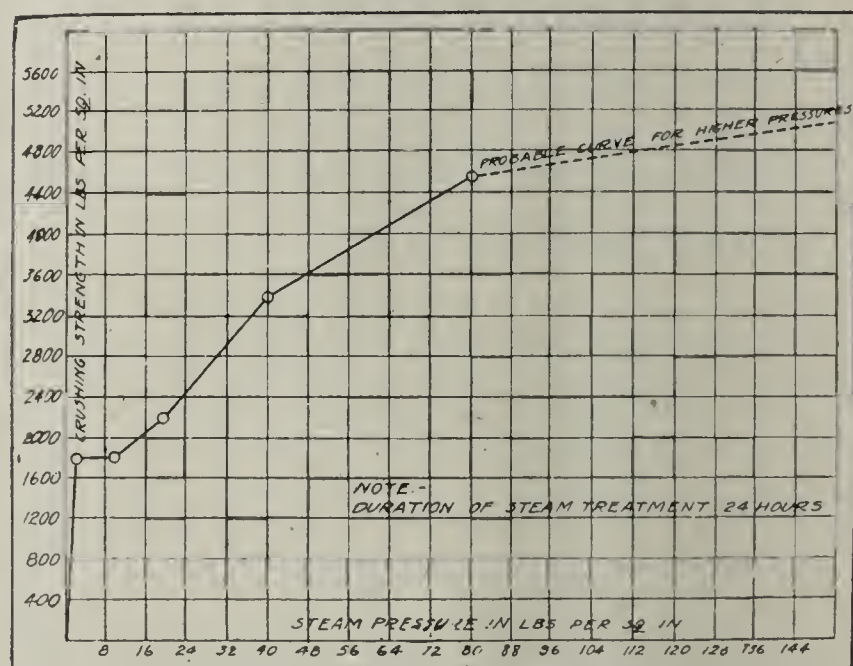


Fig. 2. Curve Showing Increase in Crushing Strength Due to Increase of Steam Pressure in which Concrete is Cured.

CEMENT MILL NEWS.

Despite the congestion in the cement market which has caused a number of the large cement mills in the country to either shut down or curtail their output, the Security Cement and Lime Company, the only Portland cement company operating in Maryland at the present time, is supplying cement at the rate of 3,000 barrels a day. This supply is 1,000 barrels a day in excess of the mills' capacity. The excess is being supplied from the manufactured product on hand. This excessive demand will continue until the late fall.

Cement Stock Houses

Josiah Gibson, M. W. S. E.

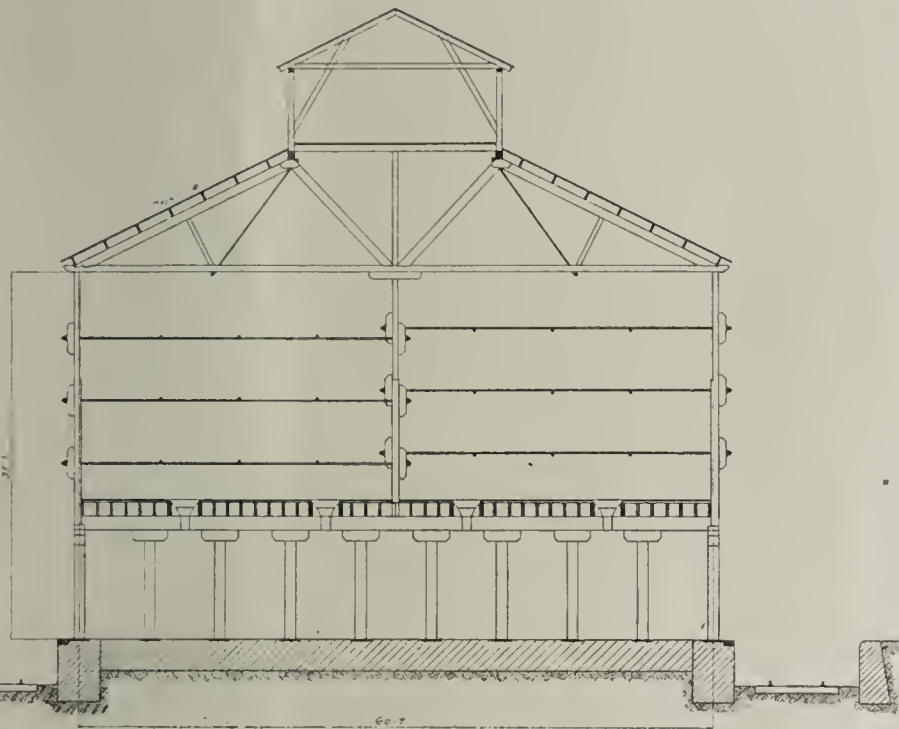
In order to provide for the seasonable variation in the consumption of Portland cement, every large plant must have a stock house in which to store the cement in bulk previous to bagging for shipment. The greatest demand occurs during the summer months

met in a variety of ways, a few of which will be briefly outlined in a history of the manner in which the storage proposition has been handled in plants Nos. 2 to 5, inclusive, now in operation, and in plant No. 6, which is now being built by the subsidiary companies of the United States Steel Corporation.

In the year 1899 a Portland cement plant was built by the Illinois Steel Company at South Chicago, having a daily output of about 2,000 barrels. The stock house has a storage capacity of 55,000 barrels. This stock house has sides of wood cribbing with brick veneer; the interior floors and roof trusses being of wood and of a type known as heavy mill construction. It has a span of 61 feet, a length of 168 feet, and a height of 35 feet 5 inches from ground floor to lower chord of trusses.

The storage space was provided on the second floor and was divided by partitions into sixteen separate compartments. The pressure on the side walls and interior partitions was resisted by rods running transversely and longitudinally through the building, the rods being spaced about 6 feet apart. Cement was taken into the building through the monitor floor and was taken out through hoppers at the bottom of the bins and bagged on the ground floor. This is shown in Fig. 1.

In 1904 cement plant No. 3 was built by the Illinois Steel Company at Buffington, Ind. This plant has a daily capacity of 6,000 barrels and is provided with a stock house having a capacity of 300,000 barrels. The stock house has a width of 100 feet, a length of 420 feet and a height of 31 feet from floor to lower chord of roof trusses. It is of steel frame construction with reinforced concrete side walls, and is shown in Fig. 2.

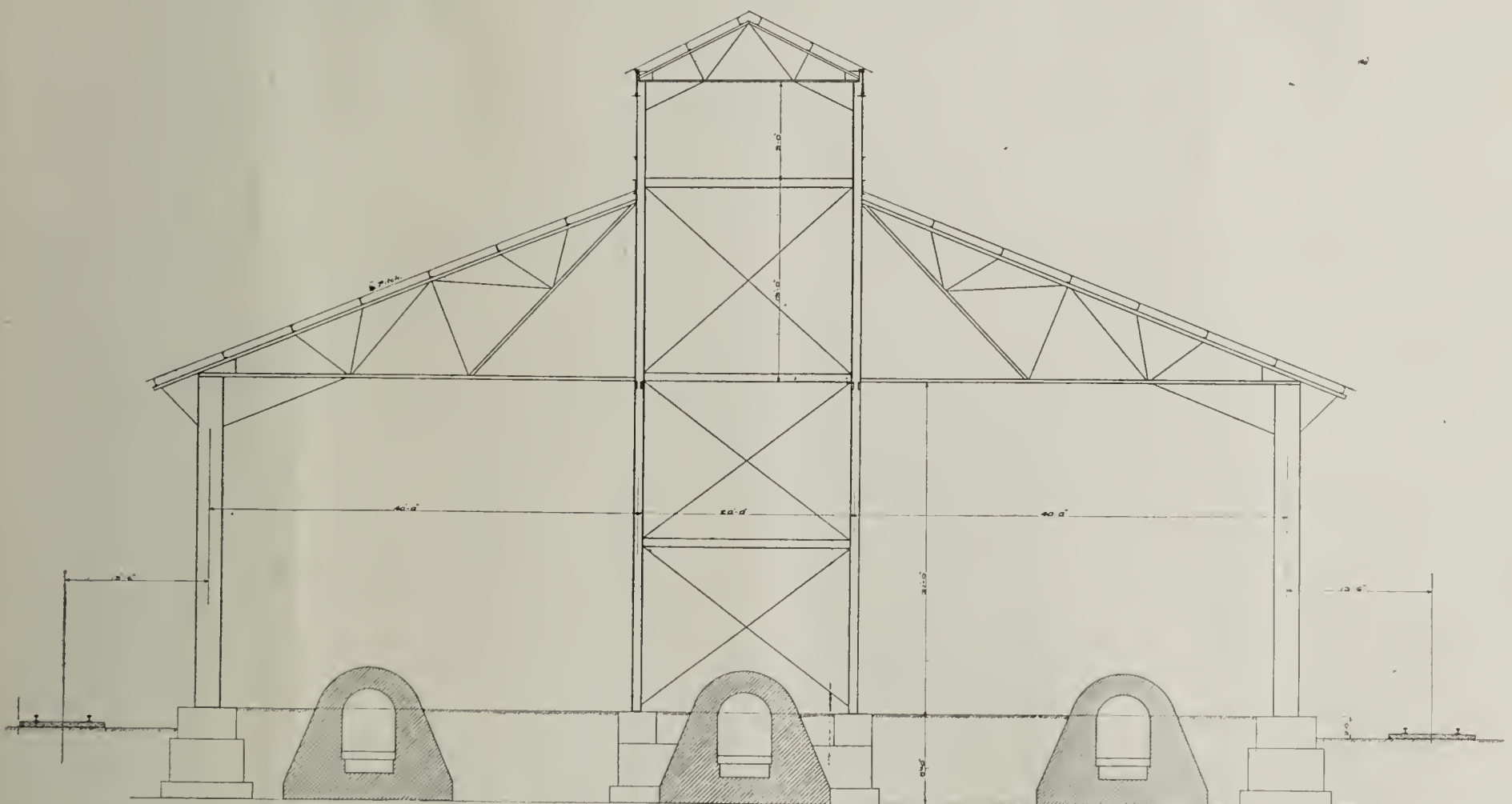


Cross Section of Stockhouse for Cement Plant No. 2

Fig. 1. Wood Construction Stock House, South Chicago.

and to provide for this demand and secure the greatest economy of production, some cement plants run throughout the entire year, and the winter surplus is stored in stock houses.

Like all other structures used in the production of Portland cement, stock houses present many new problems to the designer. These problems have been



CROSS SECTION OF STOCK HOUSE FOR CEMENT PLANT NO. 3.

Fig. 2. Plant No. 3 Steel Frame Construction, With Monitor Floor, Supported on Steel Columns, Buffington, Ind.

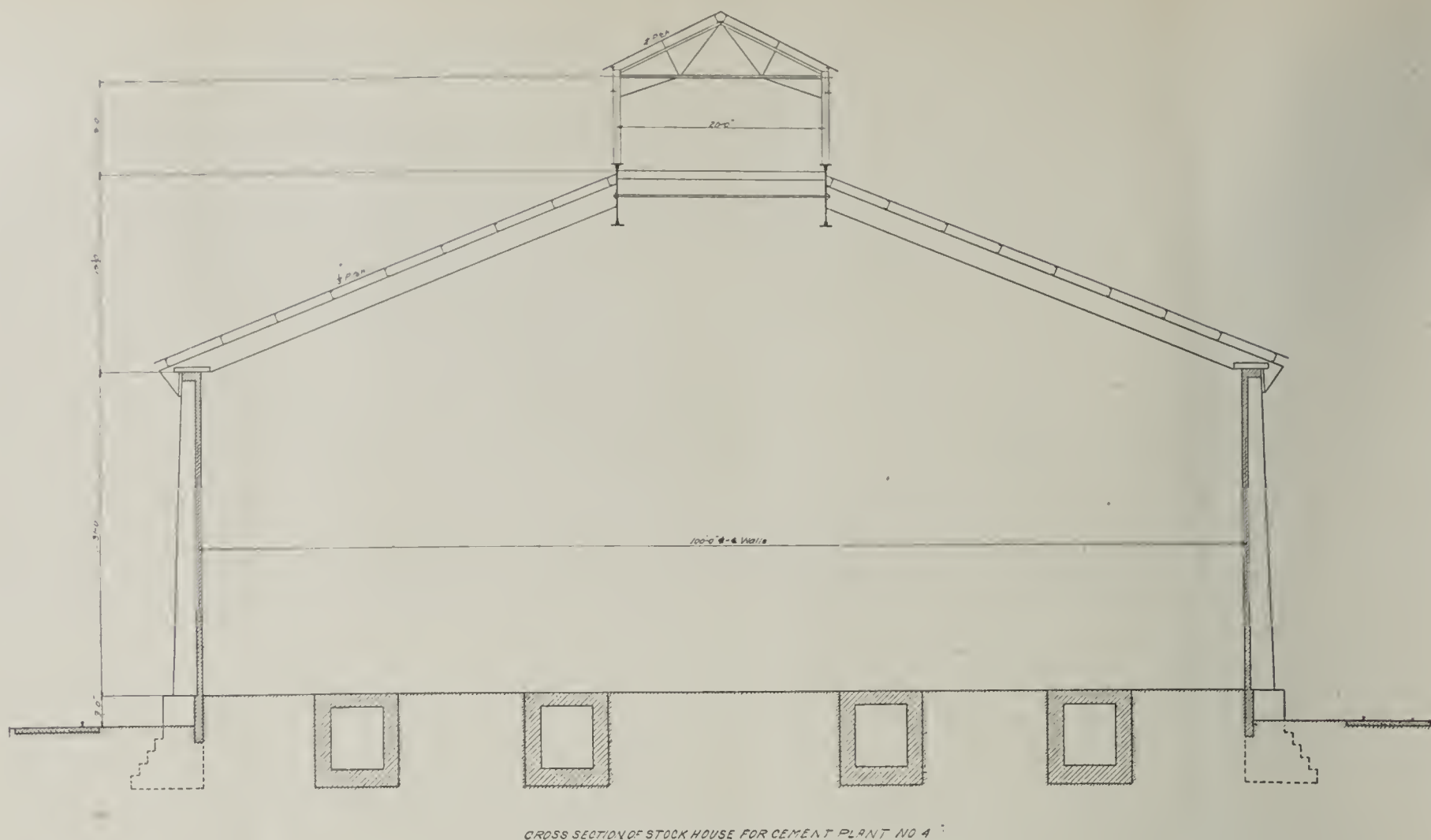


Fig. 3. Plant No. 4. Reinforced Concrete Side Walls and Monitor Floor Supported on Longitudinal Girders.

The cement is taken into the building over belt conveyors to a monitor floor and dropped through screens into the main storage space below, from where it is taken by screw conveyors through tunnels to the bagging rooms and bagged preparatory to shipping.

It will be noted that the steel roof trusses in this building are of the usual type, having a horizontal lower chord and an inclined top chord with the customary light web system between the two chords. In order to take care of the loads on the monitor floor,

two central lines of columns were provided, these lines of columns being braced together in both directions by diagonal bracing.

The defects of this form of construction became apparent shortly after the building was put in use, and in order to understand these defects it will be necessary to describe a few of the characteristics of cement. When brought to the stock house from the finishing mill, the cement is a finely ground powder which weighs about 95 pounds per cubic foot, and is very

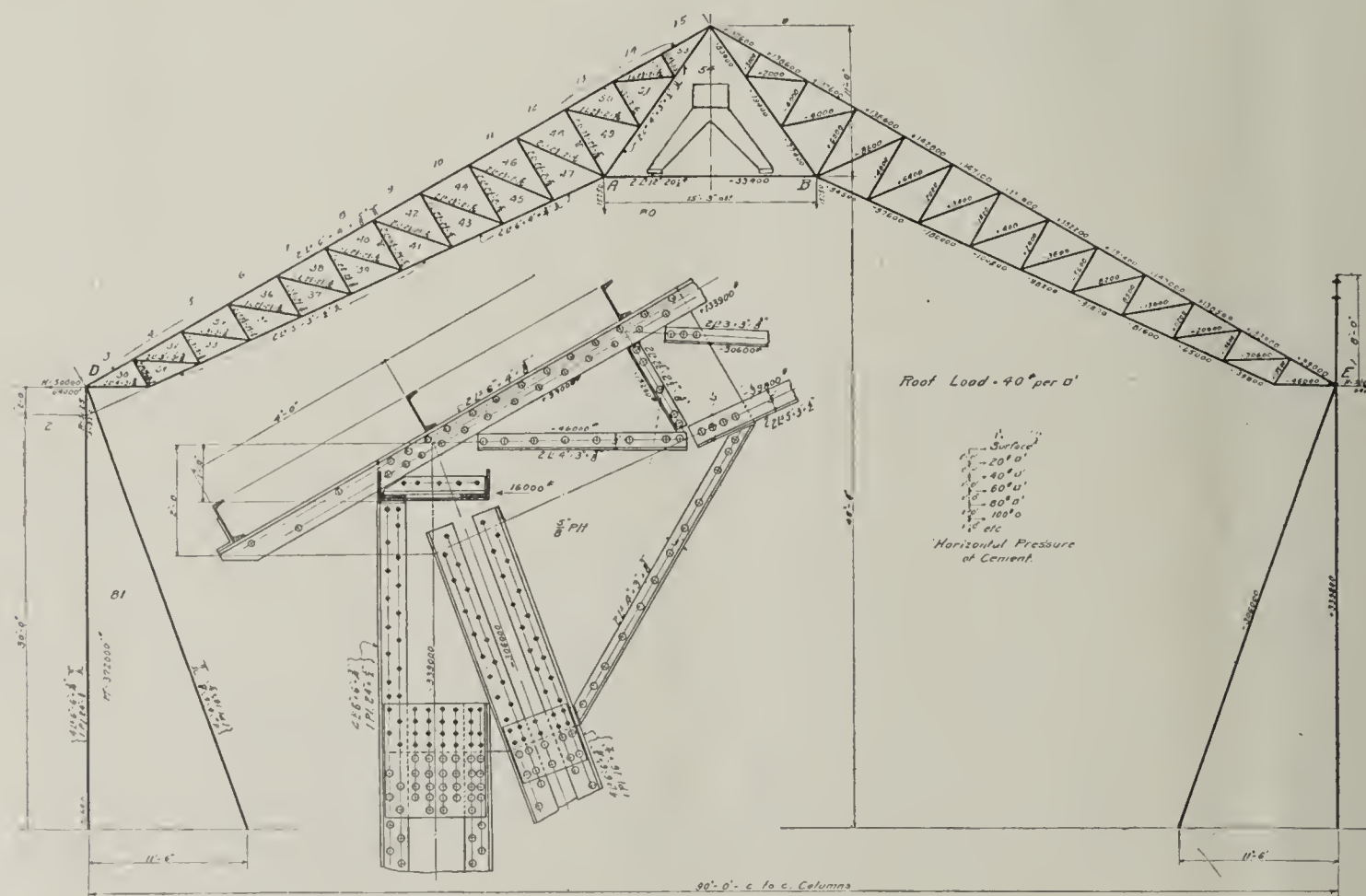


Fig. 4. Stock House for Plant No. 5 at Universal, Pa.

warm and dry. Upon being dropped through the monitor floor to the space below, it becomes freely charged with air and acts much like a liquid, the top surface being almost level. After standing a few days its weight causes it to settle and form a closely packed mass, from which practically all the air has been expelled. This mass has some peculiar properties which have been found to be very destructive to the exposed members of the steel work.

Although the cement is as finely ground as flour, and slides freely on itself under ordinary circumstances, it has been found that, under the action of the screw conveyors underneath the floor, sections of the storage space may be emptied, leaving the balance stacked up in masses with almost perpendicular sides.

to endanger the strength of the structure. The principal lesson to be learned from this experience is that cement stock houses should be made so that the caking and sliding of the cement shall not be permitted to act directly on the lighter members of the supporting steel structure.

In 1906 the Universal Portland Cement Company took over the cement plants then being operated by the Illinois Steel Company, and in 1907 cement plant No. 4 was built at Buffington, Ind. The stock house for this plant is 100 feet wide, 560 feet long and 50 feet high to the monitor floor, the total storing capacity being about 400,000 barrels. The side walls of this building were made of reinforced concrete. The upper reaction of the horizontal pressures against the

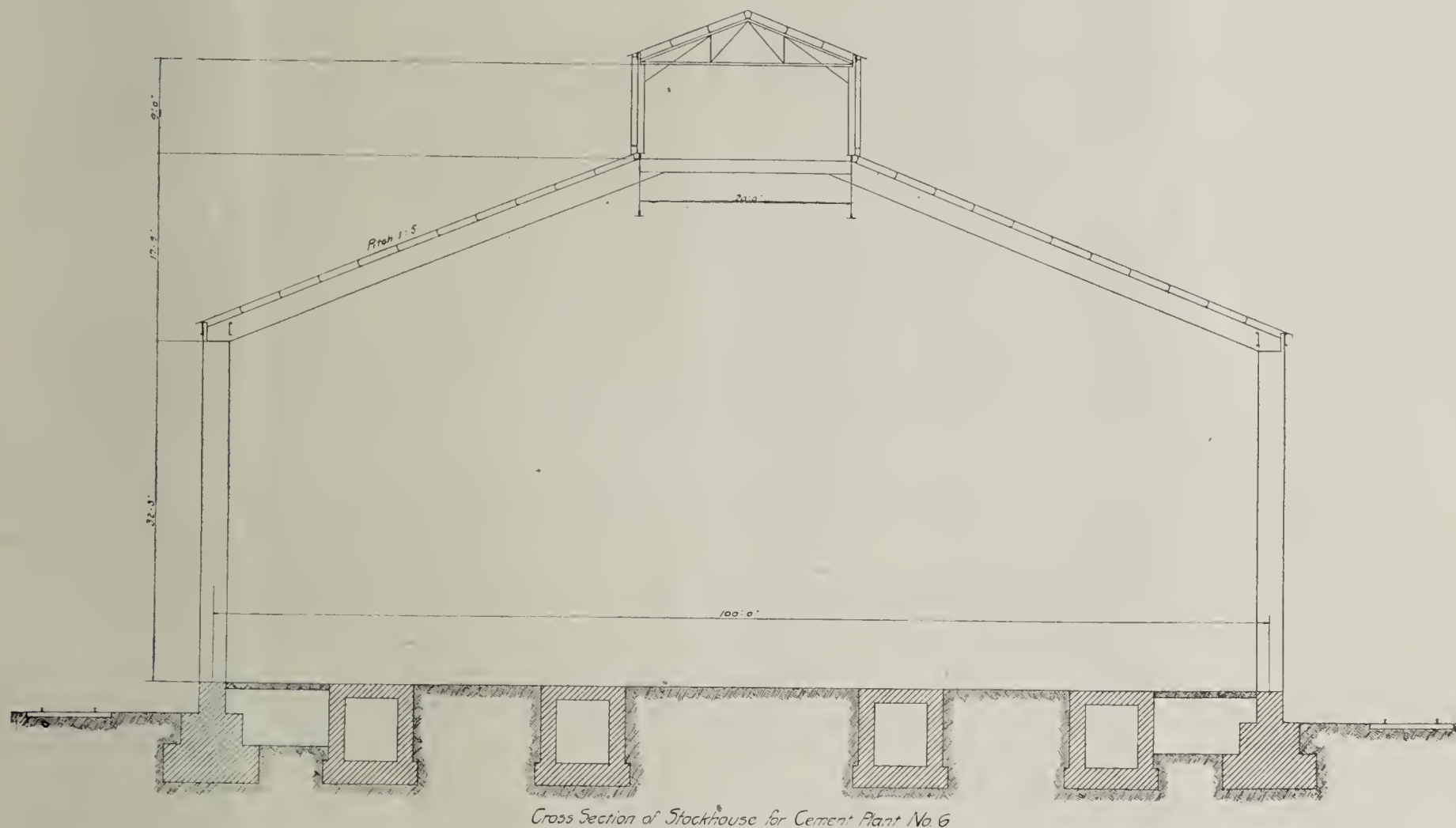


Fig. 5. Stock House for Cement Plant No. 6, Buffington, Ind. Reinforced Concrete Side Walls With Steel Columns.

These masses seem to stand for a short time, but finally collapse under their own weight and drive with great force against the side walls and interior members of the bins.

In the case of the stock house for cement plant No. 3, the interior columns were bent and twisted under the action of sliding loads, while the bracing in the lower chord of the roof trusses, and also some of the web members of the roof trusses themselves, were completely sheared off.

The knee braces, sections of the lower chord, and the upper section of the main column, showed the results of forces which were not previously known to exist in structures of this kind. The bracing between the columns was removed and the columns themselves were encased with concrete. In order to prevent the destructive loads on the members of the roof trusses, great care is now taken to avoid filling this stock house above the level of the lower chords of the roof trusses.

This building is still in service, but the dust arising from the cement continues to gather in masses on the roof trusses, and constant watching is necessary to see that the accumulation does not become large enough

side walls is transferred by heavy rafters to longitudinal girders extending between partitions placed every 60 feet throughout the storage space. This is shown in Fig. 3.

Before designing the building, an elaborate series of experiments were made to determine the horizontal pressure of cement against the vertical side walls, and also to determine the increase of pressure due to the depth of the cement. It was decided that the building should be made to withstand a horizontal pressure of 10 pounds per square foot at a depth of one foot, and an additional pressure of 10 pounds per square foot for every additional foot of depth. In other words, it was to be strong enough to resist the action of a liquid having a weight of 10 pounds per cubic foot.

When the structure was first filled with cement, the side walls deflected to such an extent that the building was not considered thoroughly safe, and after the first load was taken out, the reinforced concrete pilasters were strengthened by interior reinforced concrete buttresses, the toes of which were attached to the unloading tunnels. The excessive deflection of



the side walls of this building are supposed to have been due to the pressure exerted by the collapsing of large masses of the cement, which was much more destructive than the pressure which they were designed to resist. It was therefore decided to use a horizontal pressure of 20 pounds per square foot for each foot of depth in the design of future structures of this kind.

Plant No. 5 was built in 1909 by the Universal Portland Cement Company at Universal, which is a small town near Pittsburg, Pa. The capacity of this plant is 12,000 barrels per day. There are two stock houses, each having a width of 100 feet. The total storage capacity of the two stock houses is about 700,000 barrels. The side walls are made of reinforced concrete, supported by steel superstructures consisting of horizontal arch roof trusses supported on "A" frames having their perpendicular legs located in the plane of the side walls. These structures differ from the stock houses for plants Nos. 3 and 4 in the fact that there is no monitor on the roof trusses, the material being brought into the buildings over unloading floors which are centrally located in the planes of the elevated lower chords. It will be noted that very shallow roof trusses are used, thus producing high stresses and heavy members. This is to provide against the destructive loads from the masses of cement which accumulate on the exposed steel work.

The horizontal thrust against the side walls is resisted by the "A" frames, the interior legs of which are completely covered by concrete. No defects have yet developed in these stock houses, although they have probably not been long enough in use to afford a complete test of their strength and utility. See Fig. 4.

Plant No. 6 of the Universal Portland Cement Company is now being built at Buffington, Ind. The design of the stock house for this plant is the main subject for discussion this evening. See Fig. 5.

This building has a span of 100 feet, and when completed will have a length of 1,000 feet. The total capacity of plant No. 6 is 13,000 barrels per day, and the stock house when completed will have a capacity of about 800,000 barrels. The building, however, is being put up in two sections, the present section being 560 feet long. It is this section only which will be described. It has a capacity of 480,000 barrels, and is made up of six storage bins each 60 feet long by 100 ft. wide, four storage bins each 60 ft. long by 50 ft. wide, and two packing rooms each 40 ft. wide and 100 ft. long. The four small bins at the west end are used for storing cement which is subject to bin inspection. The large bins have a capacity of about 60,000 bbls. of cement and the smaller bins will hold about 30,000 bbl. each. This is shown in Fig. 6 and Fig. 8.

The steel work was designed in accordance with the specifications of the American Railway Engineering and Maintenance of Way Association, except that the customary unit stresses were increased by 25 per cent for beams and columns which are completely surrounded by concrete. In the design of the reinforced concrete a modulus of elasticity of 30,000,000 was assumed for the reinforcing steel, and a modulus of 3,000,000 was assumed for the concrete, while a unit stress of 20,000 pounds per square inch was used for the steel and 750 pounds per square inch was used for the concrete.

The loads for which the building was designed were as follows:

- (1) The dead load of the structure.
- (2) A dust load on the roof of 20 lbs. per sq. ft.
- (3) A snow load on the roof of 15 lbs. per sq. ft.
- (4) Wind pressure due to a velocity of 90 miles per hour, or a pressure on vertical plane surfaces of 20

pounds per sq. ft. and 10 pounds per sq. ft. acting normally to the one-fifth pitch roof.

(5) The action of a full or partial load of cement weighing 95 pounds per cu. ft. and having a horizontal thrust equal in intensity to that of a liquid weighing 20 lbs. per cu. ft.

The cement stored in each of the 60 foot bins weighs about 11,000 tons, and the total weight of all the cement that can be stored in all the bins is about 90,000 tons. The total ground area of the storage space is 48,000 sq. ft. It will be seen that the above weight produces a load on each square foot of bin floor of about two tons. Considering the horizontal action of the cement as given above, it is found that the total bursting force, or, in other words, the force which tends to push out the side walls, is 12,480 tons. One-third of this force, or 4,160 tons, is transferred by the side walls to the roof system, and the remaining two-thirds, or 8,320 tons, is transferred by the side walls directly to the foundation.

The side walls are of reinforced concrete supported by vertical steel columns. The main columns are spaced 20 feet apart and the intermediate columns are located midway between the main columns. The maximum pressure on these walls at the ends of the building is about 980 pounds per sq. ft., and at the sides of the building about 800 pounds per sq. ft.

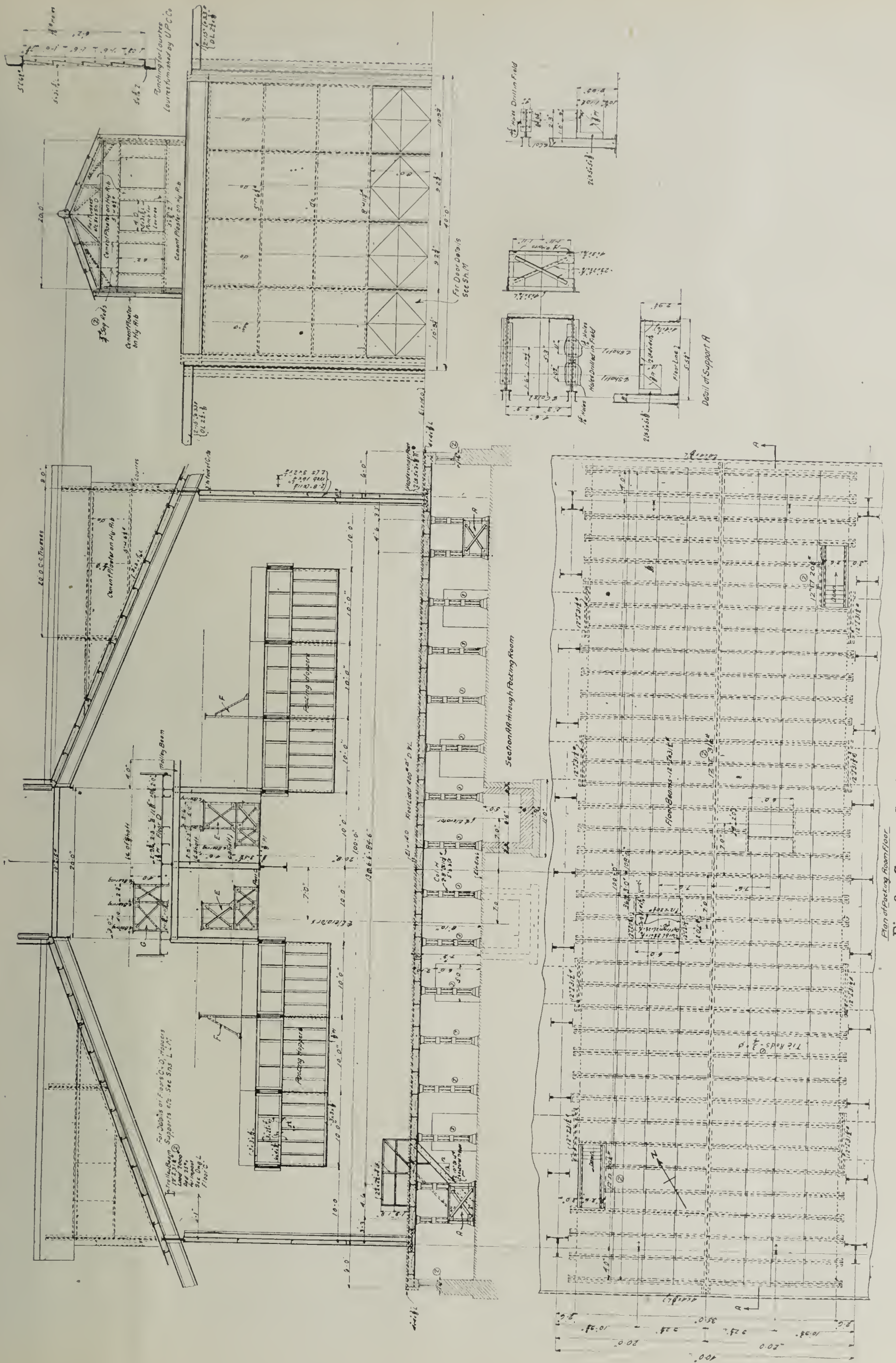
Square reinforcing bars were used throughout; the main bars were placed horizontally, 6 inches apart, and temperature bars were placed vertically 12 inches apart. The thickness of the walls in all cases is 12 inches at the bottom, 8 inches at the top, and 10 inches in the middle section. All the main side walls have columns with webs 30 inches wide, while the main partitions and end walls have webs 36 inches wide. In order to hold the horizontal reinforcing bars in their proper places, holes were punched in the web of all columns and all the bars were placed in position before starting to pour the concrete.

At the top of all walls the reinforced concrete is corbeled out so as to completely fill the heavy double-channel eave strut, and at the bottom of the walls they are corbeled out to the width of the foundations. The flange angles of the main columns show on both sides of the wall and the concrete is corbeled out to them, thus giving a fine paneled effect to all the outside walls. This is shown in Fig. 7, as also the steel framing of the bin partition walls.

The heavy outward pressure at the bottom of each of the main columns is resisted, by connecting the column bases with the tunnels which run beneath the floor by a reinforced concrete wall already shown on the foundation plan. A separate masonry plate is provided for leveling up on the concrete beneath the column bases. This masonry plate has an angle on each side at the top of the reinforced concrete walls, and the anchor bolts fit tightly through it. At the center of this plate is a 3 inch hole, through which the grout is poured after the plate is in position and carefully leveled.

The top re-action of the intermediate columns is transferred through heavy double-channel eave struts to the main columns, and thence through the main rafters, which are placed 20 feet apart, to the monitor floor. This floor is thoroughly braced to take all the horizontal forces placed upon it by the main rafters.

The Lunkenheimer Co. of Cincinnati entertained, according to the "Enquirer," more than 3,000 engineers during the twenty-ninth annual convention of the National Association of Stationary Engineers.



Destruction of Cement Mortars and Concrete Through Expansion and Contraction

By Alfred H. White

The change in volume of concrete due to temperature change has been determined with considerable accuracy to be for unit length 0.0000055 or 0.00055% per degree Fahrenheit. There are, however, other changes due to the chemical processes of setting and hardening which are barely mentioned in even the more important treatises and other variations due to the wetting and drying of the concrete whose very existence is practically unknown. It is with these two latter classes of changes that this paper will deal.

Review of Literature.

The literature of the subject is brief.

Quantitative measurements of the change of volume of cements while hardening commence with the classic experiments of Bauschinger who in 1879 reported on the change in volume of eight different cements made into small cubes of neat cement and 1:3 and 1:5 mortar. One set of cubes was kept in water and one in air and the changes in length of one side observed for 16 weeks. The most important study of the subject was made by Schumann, who, in 1881 and 1889 reported to the German Association of Portland Cement Manufacturers the result of expansion measurements made on blocks not only of neat cement and cement mortar but also on blocks of building stone. Gary in 1899 reported from the Royal Mechanical Experiment Station at Gross Lichterfelde the results of the tests on ten Portland cements carried out jointly by the Experiment Station and a committee of the Association of German Portland Cement manufacturers. The tests included measurements of expansion bars of neat cement and of 1:3 mortar placed in water. No tests were made of bars in air. The average results of the expansion tests at the experiment station are given in Table 1.

A few results by Tomei were quoted by Gary before the International Engineering Congress in 1893.

Campbell and White in 1906 presented a study of 56 expansion bars of neat cement which had been under observation for five years. A number of these were pathological specimens of unsound cement containing free lime and magnesia, but their experiments showed as much as 0.19% expansion with sound neat cements kept in water for five years and a shrinkage as high as 0.39% with bars of sound neat cement kept in air. A reliable and inexpensive micrometer and a satisfactory method of inserting the glass plates in the expansion bars were described in this paper. These improvements obviate the difficulties found by some of the earlier German investigators in getting concordant results. Table I presents the condensed data of the investigators mentioned.

The foregoing tests were all made on small bars without metal reinforcement. So far as the author has been able to discover, only two investigators have ever attempted to study the most important subject of volume changes in reinforced concrete. Consider in 1899 reported the behavior of small bars of neat cement and of mortar made with 600 Kg. cement to each cubic meter of sand. The prisms were 60 × 25 × 600 mm. Half of them were reinforced each with a round steel bar 10.2 mm. in diameter. The measurements extended over a period of 63 days and at the close of

the period showed the following changes reported as mm. per 100 mm.

	In water.	In air.
Neat cement not reinforced.....	+0.079	—0.132
Neat cement reinforced.....	+0.022	—0.025
Mortar not reinforced.....	+0.028	—0.050
Mortar reinforced	+0.006	—0.010

Emerson in 1904 studied the change in length of the reinforcement. Bars of neat cement and of concrete of various proportions were made 8x8 ins. x3 ft., each bar carrying a steel rod ½-in. square and 3 ft. 6 ins. long. The progressive changes in the length of the rods were measured for 3 months and the resulting stresses in the steel calculated from Hooke's law. The final measurements on bars kept constantly in water showed a tension stress on the steel amounting to about 8,000 lbs., per sq. in. when bedded in neat cement and decreasing to a little over 1,000 lbs. in 1:3:6 concrete. On bars kept constantly in air the steel was shown to be under a compression stress which was usually greater than the tension stress developed in bars kept under water. When bars taken from water were placed in air the stresses in the steel changed from tension to compression as the bars dried. No direct measurements were made on the volume changes in the concrete.

Only one experiment seems to have been made on a really large scale. Binnie constructed a block of 1:4 granite concrete 100 ft. in length and 1 ft. square built on rollers so as to be free to expand. He dismisses the subject of effect of moisture with the unsatisfactory statement that in wet weather the expansion due to moisture was often as much as that due to summer heat.

The experiments of the investigators cited above agree in showing that neat cements hardening under water expand at a decreasing rate for several years, that neat cements hardening in the air contract in a similar manner and that cement-sand mortars change in the same direction as the neat cements but to a lesser extent.

The effect of alternately wetting and drying concretes is given qualitatively from the experiments of Emerson. Quantitative measurements are entirely lacking. It is worthy of comment that although several investigators have reported on the behavior of bars in water for periods of several years, none have reported on the behavior of bars kept in air for a period of more than four months, with the single exception of Campbell and White, who studied one commercial cement during four years.

This curious laxness in the study of the properties of Portland cement which, next to steel, is the world's most important building material, arises probably from two causes. In the early days of the Portland cement industry the material was used almost entirely for structures such as foundations where it was kept constantly damp. It justified itself under these conditions and the assurance with which it was used, in damp places transferred itself unthinkingly to conditions where cement is less stable. The other reason for the oversight is probably to be found in the fact that few engineers who use cement have had the

TABLE I.—CHANGE IN VOLUME OF BARS OF NEAT CEMENT AND CEMENT MORTAR.
Expansion after lying continuously in water:

	Neat Cement.	1:3 Sand.	1:5 Sand.	Duration.
Bauschinger Av. of 8.....	+0.046%	+0.009%	+0.001%	16 weeks
Schumann Av. of 7.....	+0.150	+0.028	....	1 year
.....	....	+0.029	....	2 years
.....	....	+0.027	....	5 years
Tomöl Av. of 8.....	+0.025	+0.027	....	90 days
Considère	+0.079	+0.028	....	63 days
Gary Av. of 10.....	+0.063	+0.008	....	1 month
.....	+0.078	+0.013	....	3 months
.....	+0.094	+0.012	....	1 year
.....	+0.092	+0.020	....	2 years
Campbell and White.....	+0.190	....	....	5 years
Contraction after lying continuously in air:				
Bauschinger Av. of 8.....	−0.214%	−0.132%	−0.124%	16 weeks
Schumann Av. of 4.....	....	−0.042	....	1 week in water then 3 weeks in air.
Tomöl Av. of 8.....	−0.201	−0.094	....	90 days
Considère	−0.132	−0.050	....	63 days
Campbell and White.....	−0.390	....	....	5 years

TABLE II.—CHANGES IN VOLUME OF BRICK AND STONE WHEN ALTERNATELY WET AND DRIED, ACCORDING TO SCHUMANN.

	2 weeks in water.	2 weeks in air.
Brick, light burned red.....	+0.016%	−0.015%
Brick, hard burned white.....	+0.010	−0.009
Brick, hard burned white.....	+0.019	−0.010
Brick, very hard burned black.....	+0.006	−0.008
Sandstone, red fine grained.....	+0.006	−0.018
Sandstone, red coarse.....	+0.016	−0.023
Sandstone, green fine grained.....	+0.050	−0.050
Sandstone, red fine grained.....	+0.050	−0.050
Sandstone, red very fine grained....	+0.206	−0.178
Limestone, white	+0.004	−0.008
Limestone, Lothringer Lias.....	+0.007	−0.008
Limestone, Challe	+0.011	−0.009
Limestone, dense containing clay...	+0.026	−0.026
Granite	+0.006	−0.015
Basalt, a	+0.041	−0.050
Basalt, b	+0.026	−0.027
Basalt, c	+0.048	−0.050
Basalt, d	+0.023	−0.057

chemical training which would enable them to study the complex phenomena involved in these changes.

The following paragraphs show especially the effect of alternately wetting and drying bars of neat cement and sand mortar. There are also included the behavior of various bars of neat cement kept continuously in water and in air. These are included not only because more data on the subject is desirable but because the Portland cement now being used is a different material from that tested by the European investigators, who undoubtedly worked with cements made in the old vertical kilns. The modern American cement made in rotary kilns differs from the older not only in method of manufacture but also in chemical composition and is worthy of separate study.

University of Michigan Tests.

EXPERIMENTAL METHOD.—The method of making and measuring the expansion bars was that of Campbell and White. The dimensions of the bars are approximately $4 \times 1 \times 1$ in. and they contain beveled glass plates cast into the end to ensure a smooth surface for the micrometric measurements. The Portland cements used were all commercial samples which passed successfully the standard tests for soundness. Standard methods were used in proportioning the water and in mixing. The initial measurement was made after the bar had stood 24 hours in the damp box.

Campbell's perfected micrometer is described and illustrated in the paper referred to. It is possible to make three successive readings with it with a maximum error of about 0.005 mm. Since the bars, after the thickness of the glass plates embedded in the end is deducted, are almost exactly 100 mm. long, each 0.001 mm. equals 0.001%. In making measurements three successive readings are taken and the mean recorded. The bars and micrometer are kept continuously in a room surrounded on all sides by other rooms in a building whose temperature in winter is controlled by automatic thermostats. During cold

weather the temperature of the room will not vary more than two or three degrees from 70° F. In summer the temperature may rise to 80° F. Since the difference in the coefficients of expansion of the cast iron yoke of the micrometer and of concrete is only 0.0000005 temperature variation in the room introduces merely a negligible error.

Contraction of Neat Cement in Air.

The curves of Fig. 1 show the linear shrinkage of bars of neat cement kept constantly in air. Four different brands of commercial cement all passing standard specifications for constancy of volume are represented. The volume of these bars varies with the humidity of the air, but on the whole the shrinkage of all the bars is reasonably uniform and averages:

7 day (Av. of 6).....	−0.109%
28 days (Av. of 6).....	−0.190
6 months (Av. of 6).....	−0.236
1 year (Av. of 5).....	−0.270
2 years (Av. of 5).....	−0.289
4 years (Av. of 3).....	−0.322

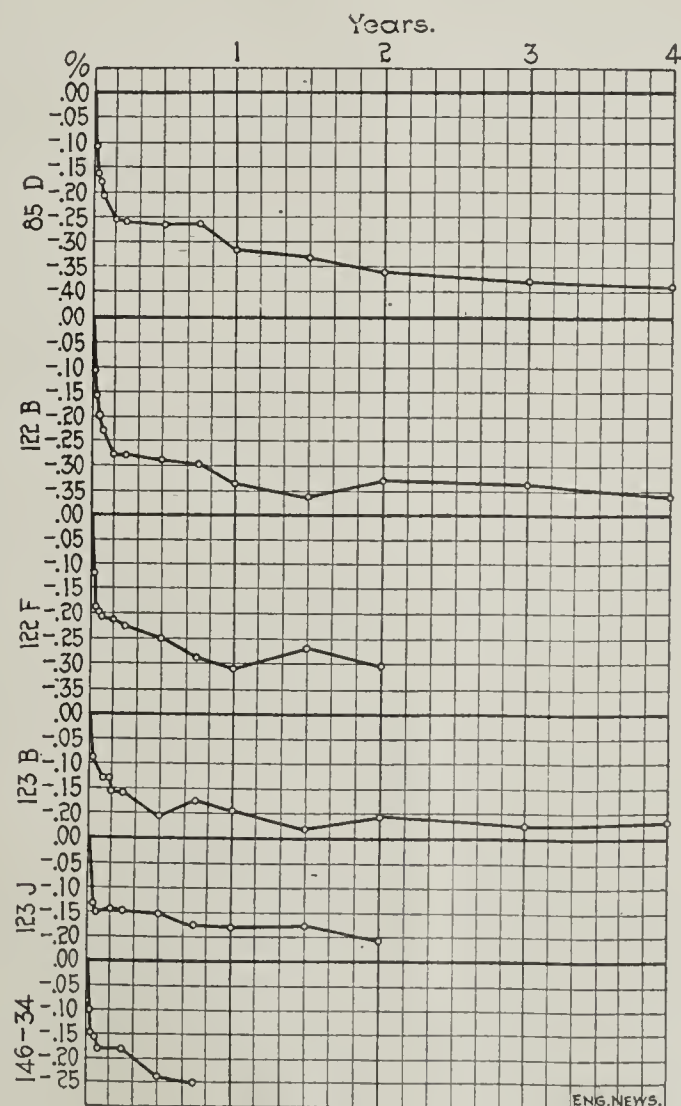
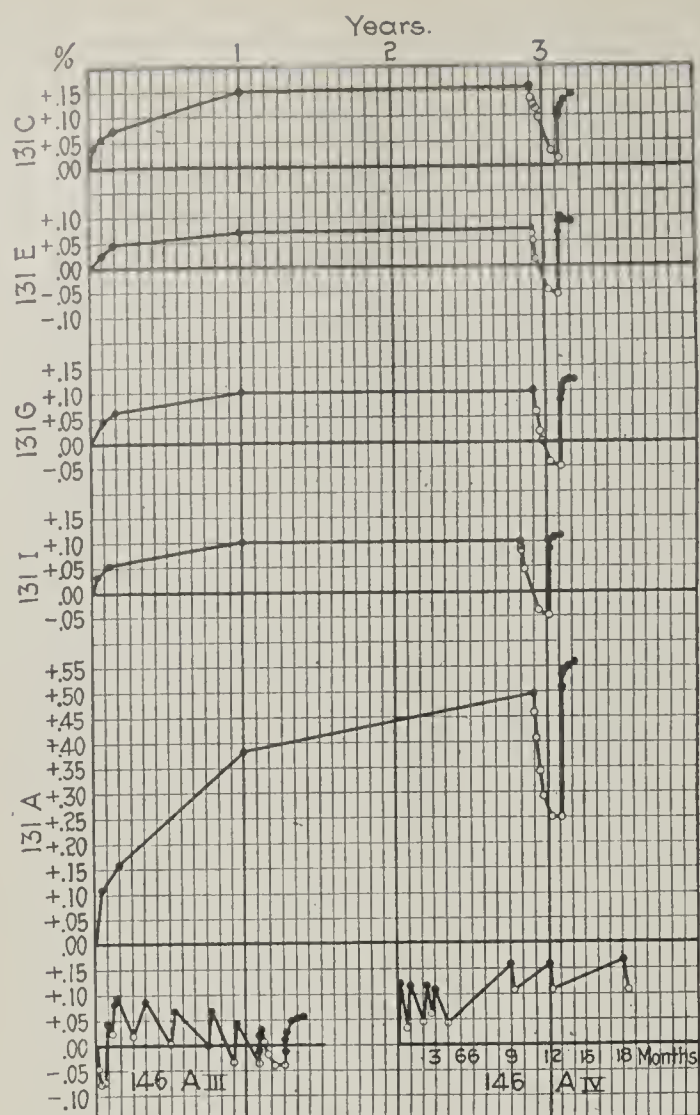


Fig. 1. Linear Contraction of Bars of Neat Cement Kept in Air for Four Years, Expressed in Per Cent.



Closed circles indicate measurements of bars taken from water.
Open circles indicate measurements of bars lying in air.
Fig. 2. Linear Expansion and Contraction of Bars of Neat Cement When Alternately Wet and Dry, Expressed in Per Cent.

It is evident that one-third of the shrinkage comes in the first week, more than half of it in the first month and almost all of it in the first year. A shrinkage of 0.322% amounts to nearly 4 ins. on 100 ft. and indicates clearly why it is not possible to use neat cement for interior floors and wall finishes. The change in volume of cement and sand mortars will be treated later.

It is often held that the use of fresh cement is responsible for cracks in finished work. It is therefore of particular interest to note that freshness cannot be held responsible for the changes shown here. Bar 85 D was made from cement which had been stored in our laboratory for six months before use. Bar 122 B was made from an inspector's sample of commercial cement when it was received at the laboratory and 122 F was made after it had stood in an open bottle in the laboratory for two years and five months. Bar 123 B was made from a commercial cement the day after it had been ground at the mill and 123 J after it had been aged two years and six months. In neither case can any effect of ageing be noticed. The shrinkage at the end of two years is practically identical in the aged and fresh cement.

Changes in Volume of Bars of Neat Cement in Water and Alternately Wet and Dry.

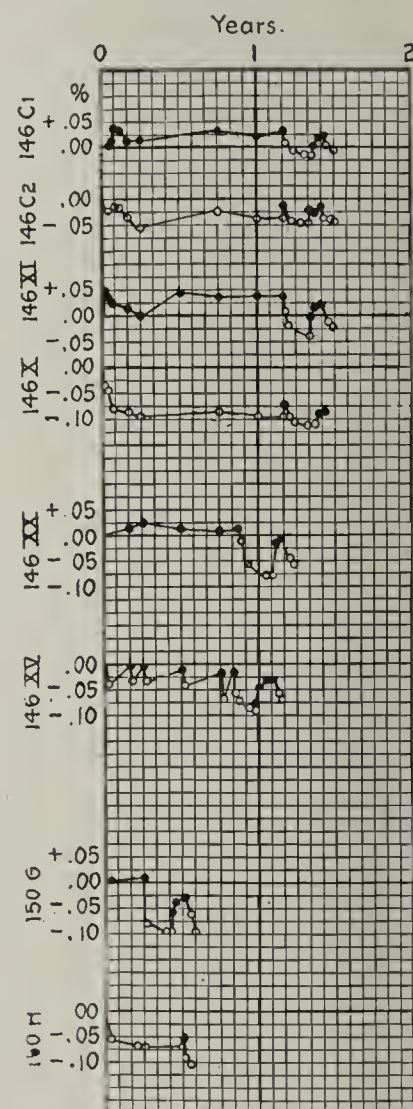
The first four curves of Plate II show the changes in four bars of neat Portland cement when kept under water at approximately constant temperature for almost three years, then allowed to dry in air for two months at the same temperature and then put back in water again. The mills represented are: 131 C, one of the largest Lehigh Valley mills; 131 E, a small Michigan mill of good reputation working wet process with marl and clay; 131 G, one of the large mills

using slag and limestone; 131 I, another Michigan mill using wet process. The fifth curve of Fig. 2 (131 A) shows the changes in a bar of natural rock cement from one of the leading mills of the country. The last curve (146 A3 and A4) show the variations in two bars of cement from still a different Michigan mill.

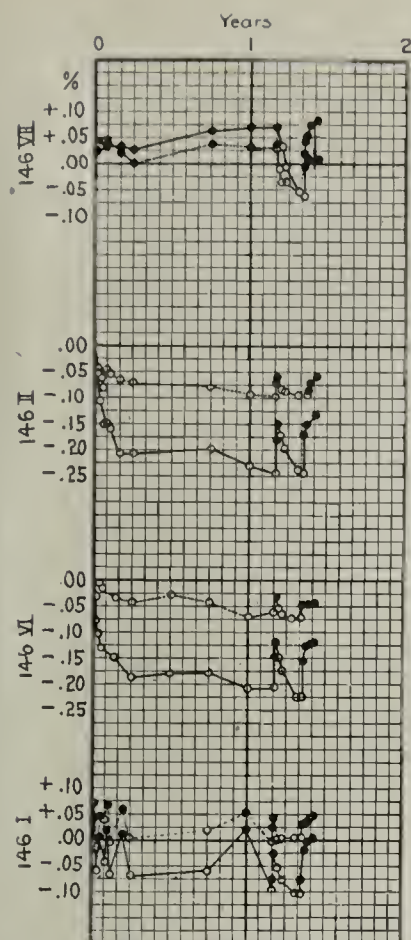
The behavior of the first four Portlands kept constantly in water for three years is quite in accord with the results obtained by European investigators. The linear expansion at the end of the first year amounts to from 0.07% to 0.15% and the expansion after the first year is very slight. The high expansion of the natural rock cement; 0.49% after three years in water is worthy of note as being quadruple that of the average of the Portlands.

Attention is especially directed to the contraction in these bars after they were removed from the water and allowed to dry in the air at room temperature. The change in volume was slow and had not entirely ceased after 65 days when the test was terminated. The values were, however, remarkably concordant, the largest contraction of the four Portlands being 0.15% and the smallest 0.13%. The bars not only shrank to their initial volume but three of the four contracted further. When the bars thus air-dried were again placed in water the expansion was rapid. In one day they recovered 90% of all the length which they had lost in 65 days air-drying and in the course of the next month they slowly expanded further until three of the four were longer than they had ever been. The exception, Bar 131 C, changes very slowly and it appears from the curve that it had not reached equilibrium either on drying or wetting.

From the standpoint of structural ability it is rather disquieting to learn that these cements which had remained in water without any measurable change in



Closed circles indicate measurements of bars taken from water.
Open circles indicate measurements of bars lying in air.
Fig. 3. Linear Expansion and Contraction of Bars of 1.3 Cement Mortar When Alternately Wet and Dry, Expressed in Per Cent.



Full lines denote neat cement.
Dotted lines denote 1.3 mortar.
Closed circles indicate measurements of bars taken from water.
Open circles indicate measurements of bars lying in air.

Fig. 4. Linear Expansion and Contraction of Compound Bars of Neat Cement and 1.3 Sand Mortar When Alternately Wet and Dried, Expressed in Per Cent.

volume from their first to their third year shrank 1.7 ins. on 100 ft., when they were dried in air and in 24 hours when again brought in contact with water expanded 1.5 ins. and within a month had expanded 1.8 ins. calculated on an initial 100-ft measurement. The question of the ultimate limit to these changes is discussed later.

The natural rock cement 131 A changed singularly but in a more marked degree. Its linear contraction on drying for 60 days amounted to 0.24% and its expansion after subsequent immersion for 24 hours in water to 0.25%. The total expansion after 30 days in water was 0.30%.

A more complete illustration of the magnitude and regularity of the changes in volume as the cement passes from the wet to the dry state is shown by the last curves of Fig. 2, Bars 146 A3 and A4. These bars have during their 18 months' existence been systematically alternated in air and water. The points make a fairly regular sawtooth curve which would probably have been more regular had a longer time been allowed for equilibrium in the early portion of the test. The last change of 146 A3, which was the most carefully watched, shows a variation from -0.038 to $+0.058$, a total change of 0.096% as it passed from the wet to the dry state for the seventh time. The behavior of these companion bars 146 A3 and A4 is treated more fully in the discussion of the behavior of sidewalks.

Change in Volume of 1:3 Sand Mortars as Alternately Wet and Dry.

Fig. 3 shows the changes in length of eight bars of Portland cement mortar mixed in the proportion of one part by weight of cement to three standard Ottawa sand. The curves are quite like those of the neat cement but the changes are on a smaller scale. The bars kept continuously in water expand within the

first few weeks as much as 0.05% but decrease after that and usually expand again later to a figure that is no greater than 0.05%. Bars kept continuously in air show greater volume changes than those kept in water, the contraction after three months averaging about 0.08% and running as high as 0.10%. When the bars change from the dry to the wet state and vice versa the change in length is about 0.06%.

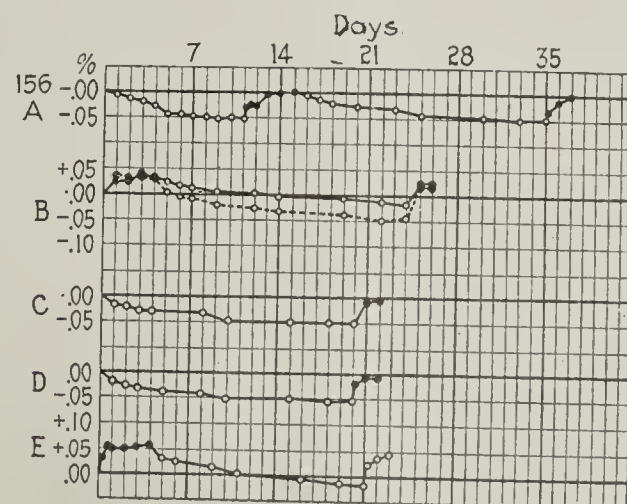
One of the best known commercial waterproofing compounds, used in accordance with the manufacturer's directions, was incorporated with the four middle bars of Fig. 3 (146 X, XI, XV, XX) in the hope that the value of such compounds might be demonstrated. There is no evidence of favorable effect, the change between the wet and dry states being full as large and apparently as prompt as in the bars not waterproofed.

Variations in Volume of Compound Bars.

In order to get a direct comparison between bars of neat cement and those made with sand under identical conditions, compound bars were made by casting a bar of neat cement integrally on a freshly formed bar of the same dimensions made by taking one of cement to three of sand. Four of these bars were made from the same lot of cement at approximately the same time. Their variations in volume are reported graphically in Fig. 4, the initial measurement of each being plotted as zero.

Compound bar 146 VII was kept continuously in water for 14 months. Both portions expanded but at unequal rates so that at the end of this period the neat bar was 0.03% longer than the one containing sand. On drying in air both shrank, but the mortar bar contracted the more rapidly so that at the end of a week the neat bar was 0.072% longer than the other. As the mortar bar reached equilibrium the neat bar caught up with it and even passed it so that at the end of two months it was the shorter by 0.012%. On placing in water both shot up rapidly, the sand 0.050% in 24 hours and the neat 0.086%. The neat bar kept growing until as was the case with the four neat cements previously noted, it overtopped any previous record and at the end of a month was 0.075% longer than its companion, whereas after 14 months previous immersion in water it had only been 0.038% the longer.

Compound bars 146 II and 146 VI were made to test the effect of fineness of sand. The mortar bar of 146 II was made with Standard Ottawa sand while 146 VI contained river sand from which everything coarser than 40 mesh had been sifted. Both bars



Closed circles indicate measurements of bars taken from water.
Open circles indicate measurements of bars lying in air.

Fig. 5. Linear Expansion and Contraction of Bars Cut from Stuccos and Sidewalks When Alternately Wet and Dried, Expressed in Per Cent

were kept in air for over a year and then immersed in water. No marked effect of the difference in sand can be noted. The contraction of the bar with the fine sand is rather less than that with the standard sand but the difference is not definite enough to be certain. The neat cement portions of the bars behaved alike and similarly to the others noted, contracting over 0.20% in one year. At the end of the year the neat cement bar 146 II was 0.147% shorter than its companion mortar bar and the neat bar 146 VI was 0.150% shorter than its companion. On placing in water there was the usual sharp expansion followed by a contraction as the bars were again dried in air and another expansion as they were placed in water, and so on.

Compound bar 146 I was changed every week during its first few weeks and shows the usual sharp alterations with no sign of decrease in intensity with age.

Illustration From Actual Practice.

It may be urged that the foregoing tests were all made on small bars manufactured in the laboratory and that such large values might not be obtained in actual practice. To meet this objection and also to make the case stronger the results shown in Fig. 5 are introduced. The scale in this plate is purposely changed in order that the steady nature of the changes in volume may be shown by the daily measurements. The ordinates remain the same but the abscissas are magnified 30 times, each horizontal unit representing a day.

Bar 156 A is made from a part of the cement sidewalk on the north side of the campus of the University of Michigan. It was laid in 1890 from imported German cement by the University workmen who were paid by the day and under no temptation to slight the work or skimp cement. Most of the slabs of this walk are now warped slightly so that shallow puddles of water stand in them after a rain and even after 20 years the expansion is still occasionally causing adjacent blocks to heave and form an inverted V. The top layer is split from the bottom in many places and it was from one of these pieces of the top coat that bar 156 A was sawed. An examination of its lower surface shows that the split was not due to faulty bonding, for the break has occurred not at the exact junction of the top coat and base, but just below the upper surface of the base. The top coat carries with it a thin layer of the base. This bar became dampened in the sawing process and was therefore put into water and allowed to become saturated and fully expanded before the measurement recorded as the initial was made. It will be noted that it then contracted slowly for 14 days in the air, the total shrinkage being 0.05% and that on putting it into water it expanded to practically its initial volume in four days. When removed from water it contracted again as before.

Another instance to which attention is called is bar 156 E cut from a piece of cement stucco which came loose from a brick porch after only two years service. The stucco is well mixed, has a good ring and is hard. The brand of cement used and the proportions are unknown but it is certainly a rich mixture, probably as high as 1:1. The stucco in coming off did not split off from the brick but in almost all instances carried a thin skin of the brick adhering to it showing that the fault did not lie in failure to bond the two materials together. The behavior of a bar sawed from this stucco is shown in the curves 156 E. It was sawed to shape without moistening and when placed in water for 24 hours it expanded 0.07% and reached 0.08% after four days in water. On drying

in air it slowly returned to its original volume. It is not to be wondered at that a stucco which expands practically 1 in. on 100 ft. whenever it gets thoroughly wet, should fail.

Another instance of change of volume in material which has been in use many years is afforded by the study of a section of cement sidewalk which was taken up in good condition after 20 years' service. From this was sawed one bar approximately $1 \times 2 \times 4$ ins. consisting of the top coat $1 \times \frac{3}{4} \times 4$ ins. on a section of the bottom portion $1 \times 1\frac{1}{4} \times 4$ ins. This bar (156 B) is therefore similar in many ways to the compound bars of neat cement and 1:3 mixture before referred to. This bar showed the usual expansion of both layers in water and the contraction in air which was expected. When placed in water the bottom layer expanded practically its whole amount (0.033%) in 15 mins. while the richer top layer expanded in the same time only 0.010%. At the end of 24 hours the top portion had expanded 0.028% and after three days had become practically constant with almost the identical expansion 0.035% which the bottom showed. This is interesting partly because of the evidence of alternate bending stress in the concrete due to the more rapid expansion of the lower layer and partly because of the ultimate agreement in expansion of the top and bottom portion. Note that this cement sidewalk was in good condition after 20 years' service. It is possible that its satisfactory condition is due to this agreement in coefficient of expansion of the two layers.

Another bar was sawed from the same piece of this sidewalk immediately adjacent to the first one, but instead of being left as a compound bar it was again sawed at the line of demarcation between the top and bottom coats, so that the top portion (Bar 156 C) was separated from the bottom (Bar 156 D). These two bars were then alternately wet and dried as the others had been to determine whether in the compound bar the change in volume of one portion had been influenced by the other. This has apparently not been the case in this bar for, as shown by the curve the two portions C and D expand and contract to about the same extent and at the same rate as in the compound bar B.

Summary of Experimental Data.

In the foregoing pages there has been presented data on the sadly neglected subject of expansion and contraction of hydraulic cements as they age in water and in air and as they are alternately wet and dry. It should be emphasized, however, that the number of experiments is entirely inadequate to make it proper to quote them as average results. They are to be regarded merely as illustrations of how some acceptable commercial cements have behaved. It is, however, permissible to summarize the extremes to show the range of fluctuation.

Neat cement bars hardening under water

After 1 year, expansion 0.07 to 0.15%; 1 year to 4 years, almost no change.

On drying after 3 years in water contraction 0.13—0.15%.

On wetting again expansion of 0.13—0.17%.

Neat cement bars hardening in air.

Contraction after 3 months.....0.14—0.28%

Contraction after 1 year.....1.18—0.34%

Slight increase to 4 years.

1 cement: 3 sand bars.

Hardening under water—expansion 0.61—0.05%, the greatest changes being in the first few weeks.

Hardening in air—contraction 0.06—0.09%, most

of the contraction being in the first three months.

On wetting and drying, expansion 0.04—0.09% on wetting and contraction within same limits on drying.

Compound bars made of one layer of neat cement on a layer of 1:3 sand expand and contract together but at different rates and to different degrees. The differential expansion varies from 0.00—0.15%.

The one natural rock cement tested showed twice as much variation in volume as Portland.

These variations in volume with change of moisture content do not disappear with lapse of years for changes of 0.05 and 0.06% have been observed in bars cut from sidewalks which have been laid down 20 years.

Changes in Monolithic Cement and Concrete.

These changes noted above may seem small, but when converted into other figures their real seriousness becomes apparent. The following hypothetical illustrations are presented to show the magnitude of the possible stresses.

Imagine a wall of neat Portland cement 100 ft. long anchored at each end to absolutely immovable supports. Let it be kept under water for three years. At the end of that time it would, had it been free, have expanded 0.1% or 1.2 ins. Since it is supposedly not free to expand the compression will be 0.1% and the compression stress on an assumed basis of a 5,000,000 lbs. modulus of elasticity will be 5,000 lbs. per sq. in. Perhaps the cement could withstand this pressure.

Imagine now that this cement wall becomes dry. It should contract 1.7 ins., but since it is not free there will be developed a tensile stress of 7,500 lbs. per sq. in., which is several times more than it can stand. The wall would have to crack.

Suppose this neat cement wall had been originally allowed to harden in the open air. After two years it would if free have contracted 0.25%, but since it is anchored at the ends there will be (assuming the same modulus) a tensile stress of 12,000 lbs. per sq. in. Is it not evident why neat cement is not used in practice?

If the above wall had been built of concrete with the same volume changes as the 1:3 sand bars and as the old sidewalks whose measurements are given above, its change in length between the wet and dry states would probably have amounted to 0.05% which with a modulus of elasticity of 2,500,000 lbs. per sq. in. corresponds to a stress of 1,250 lbs. per sq. in. The concrete could withstand this in compression, but not in tension. Not even our best steel will stand indefinitely repeated alternate bending stresses which stress it nearly to its elastic limit. Why should we wonder then if a rich cement mixture should ultimately crack when exposed to the stress resulting from a volume change of 0.05% every time it is exposed to rain or sunshine.

There is no experimental evidence which shows the changes in volume of leaner concrete. It is evident that the properties of the sand and rock become of increasing importance as their percentage increases. The tests by Schumann on volume changes in building stones, quoted at the commencement of this paper, show small values for limestone, but variable values for sandstones, the upper figures being almost as high as those quoted for neat cement. Whatever the values might be for crushed stone as used in concrete, it is hardly conceivable that gravels and sands which have withstood the action of the weather for centuries without disintegration can change their volume much

when wet and dried. It seems probable that in gravel concrete the volume changes decrease as the cement decreases until a certain lower limit is reached where the change in volume is purely a capillary phenomenon.

If this line of reasoning is correct those concrete structures should be most stable when exposed to the weather where there is just sufficient cement to give strength, but not enough to cause excessive volume changes. Practical experience apparently confirms this view.

Stucco.

There are many instances where stucco has remained perfect even when exposed to the weather for half a century. There are probably more instances, especially in recent years, where stucco has failed miserably in five years. The excellence of old stucco is sometimes laid to the natural rock cement with which most of it was made. It is not safe to deny this on the evidence of a single experiment, yet attention may be drawn again to the one natural rock cement which has been tested in our laboratory, whose volume changes were in every way much greater than those of Portland.

Is it not more probable that the old stucco has survived because of its lower proportion of cement? When it was simply a question of providing a rough brick or stone wall entirely durable in itself, with a smooth surface, and when in addition hydraulic cement was expensive, it was natural to use a mortar containing just enough cement to adhere to the wall. With the introduction of metal lath as the support for stucco, and the necessity of protecting the metal from corrosion, coincident with the drop in price of Portland cement came the use of richer stuccos.

The step was apparently an unfortunate one for a volume change of an inch in 100 ft. as shown by the stucco 156 E as it changes from the wet to the dry state cannot but cause cracks. They may be only hair cracks for with a crack every 12 ins., each crack need only be 0.01 in. wide to take up the whole change in volume. The elastic metal lath will probably yield without mechanical injury, but the protection against corrosion which the stucco is supposed to afford disappears with the first hair crack and unless the lath has been better protected by galvanizing or painting than most sorts are by the manufacturers, its days are numbered. It would have been better to have used a leaner stucco and kept it free from cracks.

A stucco rich in cement may also split off in time from brick where a lean stucco would have remained good. The change in volume of brick when wet and dry is according to Schuman less than 0.02%. If the change in the stucco is 0.08% there is opportunity for a stress corresponding to a volume change of 0.06% which might be 1,500 lbs. per sq. in. The fact that the stucco has not split off in one year or two years does not mean that it may not split off in five or ten.

Interior Floors.

The question of reinforced concrete is discussed in a later paragraph. Here only the changes in the concrete itself will be considered. The usual practice will be assumed in which there is a base of rather lean concrete covered with a wearing coat of mortar sometimes as rich as 1:1.

The first case assumed will be that of a cellar floor where the base is tamped down and the top coat at once put on, giving the best conditions for bonding. The whole mass gradually dries out and shrinks, but the top coat because of its high content of cement

shrinks more so that the conditions will be somewhat those represented by curves 142 II and VI of Fig. 4. The top coat will tend to split from the base, but since a cellar is always relatively damp there will probably be little trouble.

The situation is not so favorable when a top coat is to be laid on an upper floor of a concrete building. The main portion of the floor has been poured for possibly three months and has already completed most of its shrinkage. Its surface is also probably dirty so that the freshly poured mortar will not readily unite with it. Both of these circumstances are unfavorable. The fact that the main portion of the floor has already dried out and shrunk causes an even greater differential shrinkage of the top coat. The advice is usually given to wet the floor thoroughly before pouring the top coat. It would be better to keep it wet for 24 hours beforehand in order to give it an opportunity to expand to somewhere near its initial volume.

It is not surprising if under these circumstances the top splits off the base, shrinkage cracks appear, and the individual slabs curl up somewhat at the edges in the effort to relieve the shrinkage strains. In case electric conduits, etc., are bedded in the top coat their course will be indicated by shrinkage cracks following the lines of weakness which they cause. Since these floors remain continually dry, conditions will become constant after a few months, and there will be little further change.

Sidewalks and Pavements.

The chief factor which influences the behavior of sidewalks and pavements is the weather. The influence of temperature is well known and will not be dwelt on. A sidewalk usually consists of a base of rather lean concrete covered with a wearing coat of cement mortar which may be as rich as 1:1 and is not usually poorer than 1:2. The walk is cut into blocks and is sometimes provided with expansion joints.

As the walk dries out the top coat shrinks more than the bottom, as shown in the experimental study of compound bars. The effect can often be seen in sidewalks where the contraction has dished the entire slab so that shallow puddles of water stand in them after a rain. As the walk is wet by the rain the top expands more than the base. The alternate bending stresses thus developed all too often show themselves after a few years when the top coat splits off the base.

The necessity of expansion joints is now well recognized, although they are put in principally to take care of expansion due to changes of temperature. The experiments presented in this paper on both neat and sand briquettes indicate that the expansion of cements kept wet ceases at the end of the year, and that the total expansion does not amount to over 0.1%. This would require a $\frac{1}{4}$ in. expansion joint every 20 ft. In addition there must be the joints to care for the expansion due to summer heat, which for a rise of 100° F. is 0.05% about half what may be expected from moisture. To take care of the volume changes from both these causes a $\frac{1}{4}$ in. expansion joint every 10 ft. should be adequate although it does not include much margin of safety. In hot weather after a long rain these joints would be almost closed. In dry or colder weather they would be open.

According to the experimental figures any evils due to expansion should make themselves evident during the first two years, but practice does not always bear out this assumption. Reference was made at the commencement of this article to the cement walk laid around the campus of the University of Michigan 20 years ago, which is still showing expansion and

giving mute evidence of the pressure generated by occasionally thrusting up two adjacent slabs in an inverted V. This is not a phenomenon due to summer heat, for it occurs usually in the spring. What is the cause which is still making this walk expand after 20 years?

An explanation may be suggested, although it is not possible to prove it completely. It is well known that the glass of thermometers expands when heated and contracts when cooled, but not to its original length except after a long lapse of time. Thermometers which are used frequently at high temperatures keep growing longer. If they are laid away for a long period of time they shorten again and may even become shorter than when first calibrated. Metals behave similarly, so that it is not possible to utilize their expansion for making pyrometers which will not need frequent recalibration. The warping of the grate bars of fire boxes due to expansion is another illustration. It would be natural to expect by analogy that concrete would tend to a permanent expansion when it is kept wet longer and oftener than it is dry and that it would tend to become shorter under the opposite conditions. The experiments of this paper in general confirm this theory. Of the five bars of neat cement of Fig. 2 which had been kept under water for three years and were then dried out and reimmersed, all but one were longer after the reimmersion than they had been, and the one exception is apparently susceptible of explanation.

A more striking illustration is afforded by the two neat bars 146 A III and A IV which are shown at the bottom of Fig. 2. These bars were made on the same day from identical materials, but after the initial measurement A III was left in the air and A IV placed in water. They were then alternated between air and water, at first at the end of each week and afterwards at longer intervals. There is, however, a definite difference in the treatment of the two for with A III each cycle has consisted of a period in air of two or three months followed by an immersion in water of usually a week. It has therefore been dry most of its life and its mean length since the end of the first month has been steadily diminishing as the curve clearly shows. The companion bar A IV was subjected to the opposite treatment in that its long periods were in water and its short periods in air. Its mean length and also its length when wet has been steadily increasing for the 18 months of its existence, although the rate of increase since the ninth month has been slow. At its last measurement it was slightly longer than another bar of the same cement which had been kept constantly in water, but it will require a longer time to decide whether the increase is material.

This theory of the continued expansion of cement walks in a rather damp climate such as that of Michigan is the only one which seems adequately to explain the compression ridges still occasionally developing in the 20-year-old walk on the campus of the University of Michigan which has been referred to before. If the theory is correct it would indicate that there would be more trouble with cement sidewalks and pavements in wet countries than in those which are reasonably dry, and that there is need of much wider expansion joints in damp climates.

Reinforced Concrete.

It is evident from the data presented here that concrete undergoes a notable shrinkage as it dries. If a concrete beam is formed rigidly fixed at both ends, as is practically the case in skeleton concrete construction, it is evident that on hardening it must be under

an initial tensile stress due to contraction. Conditions will not be changed by the presence of steel reinforcement provided the ends are absolutely rigid. If, however, the ends of the beam yield at all and the concrete adheres to the steel, the strains will be adjusted between the two. The steel will be in compression and the concrete in tension, but to a lesser extent. In the review of the literature at the commencement of this paper attention was directed to the experimental work of Considere and to the experiments of Emerson, who found that even with mixtures as lean as those used in practice, compression stresses of 2,500 lbs. per sq. in. might be developed in the steel through the volume changes in the concrete of bars only 3 ft. long and not anchored at either end. The paucity of information on this subject should be emphasized. There is every probability that there are important stresses in all reinforced concrete work due to volume changes in the concrete of which the designers have had no knowledge. These stresses may have been to blame for some of the collapses which have occurred in reinforced work and the small number of such collapses may be more a tribute to the value of the factor of safety than to scientific knowledge.

Causes of Change of Volume.

There is no experimental work to account for these volume changes. Their progressive nature as the cement hardens in water or air make it evident that they are connected with the chemical processes of hardening. Since the hardening of cement is recognized as being essentially a process of colloid formation and change, it may seem not unreasonable to hold that the changes are connected with the volume of the colloid water. The nature of the volume changes as cement changes from the dry to the wet state is in harmony with this view. It is probable that the volume changes are also due in part to purely capillary phenomena for sandstone and other building stones expand when wet and contract when dry. The amount of the expansion and contraction of concrete decreases as less cement is used so that it appears that the changes are more a function of the cement than of the mineral aggregate.

The subject has not been sufficiently studied to show how far such factors in the manufacture of cement as chemical composition, temperature of burning, fineness of grinding and rate of setting influence the result; nor how far conditions surrounding its use such as amount of water, temperature of air, etc., affect



Fountain and Court.

Residence of C. E. Finlay, Kensington, Great Neck, L. I. Medusa White Portland Cement.

It is encouraging to note, however, that in buildings, where the beams remain dry, most of the contraction will have taken place at the end of the first three months and that from that point on the volume changes will be slight. Concrete floor beams are treacherous during the first few weeks, not only because the concrete itself is new and weak, but because of the tensile stresses developed.

There is danger that a rather slight load on a green beam may cause cracking if not total failure for it is entirely possible that the whole of the concrete is in tension and its tensile strength at that stage is very small. Several weeks should be allowed to elapse even in warm weather before the forms are taken off and the supports removed. Fortunately these tensile stresses seem to practically reach their maximum in three months, while the concrete gains in strength for a much longer period so that if a concrete building is successfully completed there does not seem to be a probability of future failure due to changes within the concrete.

it. Until the influence of these factors has been determined it will not be possible to make intelligent progress towards lessening the volume changes and increasing the reliability of structures containing Portland cement. The subject is of such importance as to merit most thorough investigation from both the chemical and mechanical side on a larger scale than has yet been attempted.

Conclusions.

Concrete hardening in a moist place and remaining continually moist throughout its life expand slightly but the compression stress developed in the concrete is probably not large enough to be injurious.

Concrete hardening in air and remaining continually dry contracts. The contraction is roughly twice as much as the expansion of concrete continually damp. This greater stress is harmful not only on account of its magnitude but because it puts the concrete in tension where it is weakest. It introduces an error of unknown magnitude into the calculations for all reinforced beams. It is responsible for the cracks in the

top coat of interior cement floors. Fortunately most of the bad effects become evident within three months.

Cement sidewalks, pavements and stuccos exposed to the weather contract when they are dry and expand when they are wet. The richer the mixture is in cement, the greater is the volume change so that there is a differential expansion between the top coat and the base of sidewalks which is often sufficient to split the two apart. So also rich stucco may be split from brick. In damp climates irregular expansion occurs apparently for as long as 20 years. Its harmful effects may not appear for many years. Large expansion joints are necessary to sidewalks and pavements.

Rich stuccos will inevitably crack through expansion and contraction and may be ruined. The few experiments made indicate that integral waterproofing compounds do not prevent or lessen the changes in volume. The only safety seems to lie in the use of lean mixtures whose volume change is slight. A stucco coat is inadequate as a protection for metal lath. If it is rich enough to keep water out it will crack. If it is lean enough to avoid the cracks water will go through it freely. In a dry climate the tendency is for sidewalks and stuccos to shrink more than they expand. Under these circumstances they will be much more durable and because of the slower corrosion stucco may be permissible as a protection for wire lath.

DEVELOPMENT SHOWN IN THE SAND-LIME BRICK INDUSTRY.

The United States Geological Survey has just published a report by Jefferson Middleton on the production of sand-lime brick in 1909, an advance chapter from the Survey's volume "Mineral resources of the United States, calendar year 1909."

The sand-lime brick industry has developed rapidly in the United States. It began in 1901 at Michigan City, Ind., with one plant producing only a few thousand bricks, which was followed shortly by a plant at Wilmington, N. C. In 1903 there were sixteen plants in operation, which marketed a product valued at \$155,040. From this small beginning the number of operating plants and the value of the product increased steadily until 1907, when 94 operating plants reported an output valued at \$1,225,769. These figures are the highest yet recorded in the industry. In common with other industries, the manufacture of sand-lime brick fell off considerably in 1908. In 1909 however, there was a small increase, and 1910 bids fair to exceed the record of 1907. This industry is now firmly established and will probably show steady growth.

This industry was started in the nineties in Germany, where there are now 280 plants in operation. In places where brick clay is not found and where sand and lime can be easily procured these bricks can be made cheaper than ordinary clay bricks. In 1902 the German Government purchased nine million bricks at a saving of \$20,000 over the cost of clay bricks.

The pamphlet can be obtained free by applying to the Director of the Survey at Washington, D. C.

Medusa Waterproofed Portland Cement is the title of a recent trade publication, issued by the Sandusky Portland Cement Co. of Sandusky, Ohio. It describes tests made of Medusa waterproofed cement and gives a list of buildings in which this cement has been used.

BOOK REVIEWS.

Directory of Portland Cement Manufacturers. Compiled and Published by Cement Era. Pages, 250; size, 3¼x5. Price, leather, \$1.00. Cement Era, 1207 Morton Building, Chicago, Ill.

This work is issued annually and already has become familiar and valuable to many in the industry. In addition to cement manufacturers, the book also lists gypsum and lime manufacturers.

The Concrete Machinery Sales Co. of Wichita, Kans., publishes a catalogue describing their "Climax" Cement Block Machines and "Climax" Concrete Mixing Machines.

NEW BOOKLET ON "CONCRETE SILOS."

The Universal Portland Cement Co., Chicago and Pittsburg, have recently prepared for free distribution a new booklet on "Concrete Silos." This is an original and comprehensive treatment of the whole subject of silage and silo building, pointing out more particularly the advantages and economy of building silos of concrete.

The increasing use of silos in the country is a significant indication of the spread of intelligent and scientific methods in farming. In many localities the whole country landscape is dotted with tall, cylindrical structures, marking in each case the adoption of advanced ideas. The introduction of the silo by one farmer often starts a movement which results in the erection of similar buildings throughout the whole neighborhood.

Cement dealers, says the Universal Company, can do a most important work in promoting the use of concrete by co-operating in the careful distribution of our Silo book among the better class of farmers with whom they do business.

NEW CATALOG OF WELLER MFG. CO. NOW READY FOR DISTRIBUTION.

What must be classified as a text book on elevating, conveying and power-transmitting machinery is the latest catalog of the Weller Mfg. Co., a copy of which we have just received. This is considered one of the most complete books ever published on this class of machinery and this fact seems fully substantiated by the book itself. No fewer than 575 pages are contained in this "encyclopedia of Weller-made products."

The appearance of the catalog is very fine, being bound in blue cloth covers with the lettering in white. It measures six and one-half by nine and one-half inches and is one and one-quarter inches thick. The size makes it very convenient for easy reference and takes up but little room on the desk.

One is struck by the thoroughness and completeness in describing the various specialties and the excellence of the illustrations. The descriptions are no more technical than is necessary and are arranged so as to be readily understood. The increasing use of this class of machinery in cement plants is too well known to need comment, but we advise every owner, manager or superintendent to write for a copy of this new catalog which is sent free upon request.

A Few of Many Structures Waterproofed with Ceresit

Swimming Pool, Ravens-
wood Y. M. C. A., Chicago.
Swimming Pool, Y. M. C.
A., Gary, Ind.
Swimming Pool, Y. M. C.
A., Hyde Park, Chicago.
Crerar-Adams Co.'s Ware-
house (\$300,000) Retaining
Walls, Chicago.
Michael Reese Hospital
Tunnel, Chicago.
Smith Building Boiler
House Pits, Chicago.
Harper Memorial Library
(\$1,000,000), entire founda-
tion, floors, etc. University
of Chicago, Chicago.
Apartment Bldg., Beacon
St., Chicago.
Sid Speigal Residence,
Winnetka, Ill.
Antiseptic Laundry, Chi-
cago, Ill., Stable Floor.
Old People's Home (\$200,-
000), retaining Walls, Chi-
cago.
Navarre Theatre, Chi-
cago.
Bowling Alley, Y. M. C.
A. Bldg., Chicago.



Italian Pool in the Country Life Gardens, Garden City, Long Island, N. Y.

Some Structures Water- proofed with Ceresit

Cribben & Sexton Co.'s
New Stove Plant, concrete
floors, foundations, Chica-
go.
Wine Cellar, Duane and
Hudson Streets, New York.
Sewer, 150 feet on Broad-
way, connecting into Cori-
landt St., Interborough
Rapid Transit Co., New
York City.
Basement for Jas. R.
Humphreys, Atlantic City.
Moline Wagon Co.'s Dry
House, Moline, Ill.
Tunnel, Windsor Station,
Can. Pac. R. R., Montreal,
Que.
Public School, Glencoe,
Ill.
Black Hawk Nat'l Bank
Bldg., Waterloo, Iowa.
Cigar Factory, Plymouth,
Wis.
Toronto University Li-
brary Bldg., Toronto, Ont.
Col. Tipton's Residence,
Sylvester, Ga.
Garage Floor, Haney-
White Co., Philadelphia.
Basement of No. 145 N.
8th St., Phila., Philadelphia
Safe Deposit Co.

This Italian Pool Is Waterproofed with Ceresit

It is impossible for water to penetrate concrete treated with Ceresit waterproofing. The Ceresit keeps out the water for all time—not in spots, but uniformly throughout the entire concrete mass, because, no matter how great the water pressure may be, the concrete itself is proof against the permeation of water.

The Ceresit method of waterproofing foundations, tunnels, and all other important engineering work is the most economical of all and as effective as any known method.

The tensile strength of concrete is not affected by the cersitizing of the mass.

"Ceresit"
Waterproofing

has a successful record of past performance on many of the most important engineering works in Europe and America and it can be relied upon always for efficiency and permanence.

The Ceresit waterproofing method is to put the Ceresit waterproofing—a cream-white paste—into the water before this water is used in mixing the concrete. The water holds the Ceresit in suspension and carries it uniformly into the concrete in the mixing process.

Thus the concrete is waterproofed through and through, not in spots as is the case with dry powders that cannot be evenly incorporated.

Chipping or scratching do not affect the water-repellant quality of cersitized concrete. This cannot be truthfully said when mere washes or paints are used for concrete waterproofing.

Cersitized concrete will not disintegrate through the action of frost because the water cannot enter the concrete and hence there is no water in the concrete to freeze.

Ceresit waterproofing stands alone and should not be confounded with powders, paints or washes sold for waterproofing.

Ceresit is the most efficient repellant for dampness and moisture when used in cement mortar employed as a coating on structures built of brick, stone, concrete or tile.

We guarantee Ceresit to equal our claims on all work done under our direction on tunnels, sewers, foundations, water-towers, tanks, pools, reservoirs, foundations of bridges, aqueducts, viaducts, retaining walls, building walls, roofs, cellars, floors, boiler pits, etc., etc.

Ceresit is catalogued in "Sweet's" Index, pages 46 and 47.

Please write for our Free Book "Q" on How to Effectively and Permanently
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manently Waterproof Con-
crete and Cement Mortar to

**Ceresit Waterproofing
Company**

Clark and Adams Sts., Chicago

CEMENT MILL NEWS.

A contract for 100,000 barrels of cement has just been placed by the Hardaway Contracting Company, Columbus, Ga., with the Standard Portland Cement Company of Birmingham, whose works are at Leeds, Ala.

This cement is to be used for the construction of the great dam at Goat Rock, on the Chattahoochee river, near Columbus, Ga.

Thirty-five thousand barrels of Standard Portland cement have already been used on this work, which with the order will make a total of 135,000 barrels.

The engineers in charge of the work are the Stone & Webster Engineering corporation, Boston, Mass.

Wellston, O., Sept 2.—Under the direction of the United States court, James O. Tripp, special master, sold yesterday at public sale the holdings of the Alma Cement Company, under a foreclosure mortgage given to the Standard Trust Company of New York, there being but one bid, that for \$500,000, the minimum price fixed by the court. The property consists of the second largest cement mill in the state and 3,300 acres of mineral land in Vinton County.

San Bernardino, Cal., Aug. 30.—A machine, which will abate the cement dust nuisance, is believed to have been successfully invented by T. J. Fleming, general manager of the California-Portland Cement plant of Colton. The plant is being installed at a cost of \$75,000, and will be in operation by the middle of September.

As a result of the suit of the orange growers against the company, the operation of the plant is enjoined unless the dust is abated.

Reference is frequently made in specifications to standard Ottawa sand, and not everyone knows where this sand for testing and laboratory purposes can be secured. This sand comes from Ottawa, Ill., and can be secured from the Ottawa Silica Company of that city. This sand is rigidly tested and accurately standardized. This company also sells white sand for construction purpose, it being unexcelled for facing concrete blocks and ornamental work of all kinds.

NEWS ITEMS.

One of the largest cement orders in years has been secured by the Tacoma branch of Balfour, Guthrie & Company. The order calls for 30,000 barrels of Golden Gate, to be used in construction of the McMillan reservoir on the new Green river gravity water project.

Edward Flad & Co., Fullerton Bldg., St. Louis, Mo., are the engineers for a 5,000,000 gallon reinforced concrete reservoir and coagulation plant for the water works system of the Anheuser-Busch Brewing Association of St. Louis. Date for receiving bids not yet decided upon.

The Crown Gypsum Co., Ltd., Lythmore, Ont., Canada, have a large plant at Cayuga, Ont., which was recently destroyed by fire.

In this issue appears the advertisement of the Blystone Batch Mixer, of which Mr. P. L. Blystone of Cambridge Springs, Pa., a cement contractor and builder of wide experience is patentee. Mr. Blystone took out his patent June 22nd, 1909, from which he has been devoting his time to their manufacture. They have become favorably known among the block, brick, and tile manufacturers as a most thorough and reliable mixer for this purpose. They are very thorough in mixing and easily cleaned. And being open and the contents in full view of the operator, the material

can be wet very accurately. These are very important points to consider in a concrete mixer to be used in a block, brick, or tile factory, where careful preparation of the material is very necessary. They are fitted with speed reducing gear, tight and loose pulleys, and are ready to put right to work, either in the shop or outside work, as they can be belted direct to the power without the use of a jack shaft.

The Blystone Manufacturing Company have recently incorporated and increased their capital stock, and are prepared to take care of their rapidly increasing sales promptly.

Sievert Bros., of Bloomville, O., have under contract and are building eleven concrete mausoleums in Ohio. They have placed an order with the Williams Contractor's Supply Company, of Columbus, O., for six No. 1 Koehring Concrete Mixers, which will be used in mixing the concrete for the building of the mausoleums.

THE "CLIMAX" LINE.

Interesting News for Contractors and Builders.

Perhaps no other line of concrete machinery has in recent years made the rapid strides in both home and foreign markets and merited such popular approval as has the "Climax" line, manufactured by the Concrete Machinery Sales Company of Wichita, Kan., U. S. A.

There is hardly a country that has not awakened to the possibilities of the "Climax" concrete block machine and needless to say, their manufacture has been a wonderful step beyond the slow, costly process of quarrying stone, cutting to the sizes and styles desired, without mentioning the expense of transporting it to the building site.

The "Climax" concrete block machine truly solves the building problem, and is conceded by leading architects, contractors, builders and engineers the world over to be pre-eminently the most satisfactory and economical on the market. A glance at its construction and compactness and clean-cut appearance, readily commends it to the discriminating buyer.

The "Climax" occupies but little space and will do the work right at the place you want it and want it most. As a rapid producer of absolutely perfect concrete blocks it has taken a lead far in advance of many other similarly intended machines, and on account of its positive adjustments as to length, width and height of blocks, it saves the buyer the price of several down-face block machines and equipment.

Another feature is its rapidity of operation, accuracy and diversification of products for with the "Climax" you can build anything from a simple wall to the most palatial residence or extensive factory. Each "Climax" machine comes fully equipped to make the various styles of face designs and a complete assortment of molds accompanies the machine. The down face feature of the "Climax" insures a harder face design, and this one advantage alone commends it to the discerning buyer who wishes permanency.

The Concrete Machinery Sales Company also manufactures four styles and sizes of continuous concrete mixers, each type being of a mixer that has done more towards revolutionizing building and concrete conditions than any other type of continuous mixer. The No. 1 "Climax" mixer has a 3 H. P. engine; the No. 2 is equipped with a 1½ H. P. engine; the No. 3 or stationary mixer is equipped for power, and the No. 4 being a hand mixer.

Prices and descriptions on both "Climax" concrete

block machines or mixers may be had from any of the following "Climax" agencies or from the company direct: New York City, John C. Hinrichs, 35 Warren street; East Rochester, The Geo. H. Pettit Co.; Boston, George Kendall, 4 P. O. Square; Baltimore, The Maryland Equipment & Supply Co., Equitable Bldg.; Chicago, T. O. Browning, 217 Chamber of Commerce Bldg.; Kansas City, J. P. Sprague Co., Rialto Bldg.; Davenport, Ia., Lumsden & Meier, Winecke Bldg.; Oklahoma City, The Mossman Co., Colcord Building; Denver, George P. Heinz & Co., Chamber of Commerce Bldg.; Atlanta, Ga., H. S. Courtney, 28 E. Alexander street.

The Concrete Machinery Sales Company also has branch sales agencies in over forty foreign countries and the universal demand for "Climax" machinery has been but the logical result of giving buyers full value for both sides of their dollar. It is worth your while to write today for descriptive literature showing the merits and advantages of the line.

TRADE NOTES.

Ten years ago the Moline Sand Co., of Moline, Ill., was established. Its yard is on Third avenue, between Twenty-fourth and Twenty-fifth, on the Mississippi River. Running into it are switch tracks from the C., B. & Q. and Chicago, Milwaukee & St. Paul Railroad. The company is erecting a new warehouse, which will be completed this fall, with a storage capacity of 10,000 barrels of cement and 1,000 barrels of plaster, and besides will have room for mortars, lime and reinforcing materials. It is the agent for the cement manufactured by the Marquette Cement Mfg. Co., and also handles the cement of the Atlas Portland Cement Co. It is exclusive agent for Mo-

line and East Moline for the plaster of the U. S. Gypsum Co. It handles fire brick and fire clay of the Chicago Retort & Fire Brick Co.

Its sand and gravel plant is equipped to handle, pump and load 600 yards of sand daily.

The Rockwood Construction Co., of Hoboken N. J., has been incorporated with a capital stock of \$100,000 to do construction work, building and contracting business. The incorporators are: K. D. Cranstoun and F. J. Vreeland, of Hoboken, N. J., and E. D. Mer-selis, of Paterson, N. J.

Blystone Manufacturing Co., Cambridge Springs, Pa., will increase its shop facilities by the erection of a building 80x100 feet. The company manufactures concrete mixers and core sand mixers.

The preservation of iron in concrete is again attested in the demolition of an old gasometer in Hamburg, Germany, as reported by "Fer et Acier," of Brussels. This structure was built about 1852 and when taken down 48 years later, the iron anchor bolts which had been completely incased in a cement concrete were found to be as fresh and bright as new iron, with no traces whatsoever of rust.

The new reinforced concrete bins of J. B. Speed & Co., at Speeds, Ind., have been completed by H. H. Snyder, of Louisville. The bins are four in number, cylindrical in shape, and have an inside diameter of 36 feet. They are 50 feet high, and owing to their economical design are expected to be used more freely hereafter by cement companies. Speed's cement, Carnegie bars and Ohio river sand were used in the con-

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The Most Economical Sprocket Wheels on the Market

Last several times as long as ordinary cast-iron wheels, and cost but little more

Are accurately fitted to the original "Ewart" chains, of which we are the designers and makers



Life of chain prolonged, because wheels are not rapidly wearing away from the proper pitch diameter

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Trade Mark. Reg. U. S. Pat. Office

The economy resulting from the use of these wheels appeals to all who appreciate durability and satisfactory service, and especially to those who wear out machinery rapidly in handling Raw Materials in Cement Mills, Phosphates, Crushed Stone, Ashes and other abrasive materials

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DENVER
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NEW ORLEANS, Wilmot Machinery Co.

BUFFALO, 601 Ellicott Square

BOSTON, 131 State Street

struction, some of which was done in cold weather, necessitating the burning of fires for the protection of the concrete. A feature of the bins is that the cement will be conveyed to the openings in the roofs by means of machinery, being let down into the bins, whence it may be withdrawn through vents in the bottom. Cars can be run under the bins on tracks in tunnels provided for the purpose, gravity performing the work of loading the cars. Plans were drawn for the bins by the cement company, assisted by W. H. Gazlay, of the National Concrete Construction Company, of Louisville.

NEWS ITEMS.

The Chicago Artificial Stone Co., Grand Rapids, Mich., is erecting a building 220x440 feet, and will manufacture all kinds of artificial stone products.

McKeever Engineering & Construction Co., Columbus, O., has been organized with a capital of \$10,000, by George McKeever, Charles E. Munson, Robert J. Wheaton, Wirt S. Scott and Ernest H. Sims.

The Neeley Cement Block & Construction Co. has been incorporated at Cortez, Colo., by William G. and William C. Neeley and Charles R. Reed, with a capital of \$25,000.

The General Cement Products Co. has been incorporated at Indianapolis, Ind., with a capital stock of \$25,000, to manufacture cement products. The incorporators are W. J. Wiley, Joseph Zeigler and Charles K. Bogot.

T. W. Snow Construction Co., Chicago, has been organized by George T. Horton, August Ziesing and Ward W. Willits, with a capital of \$150,000, to do a general fuel, contracting and construction business.

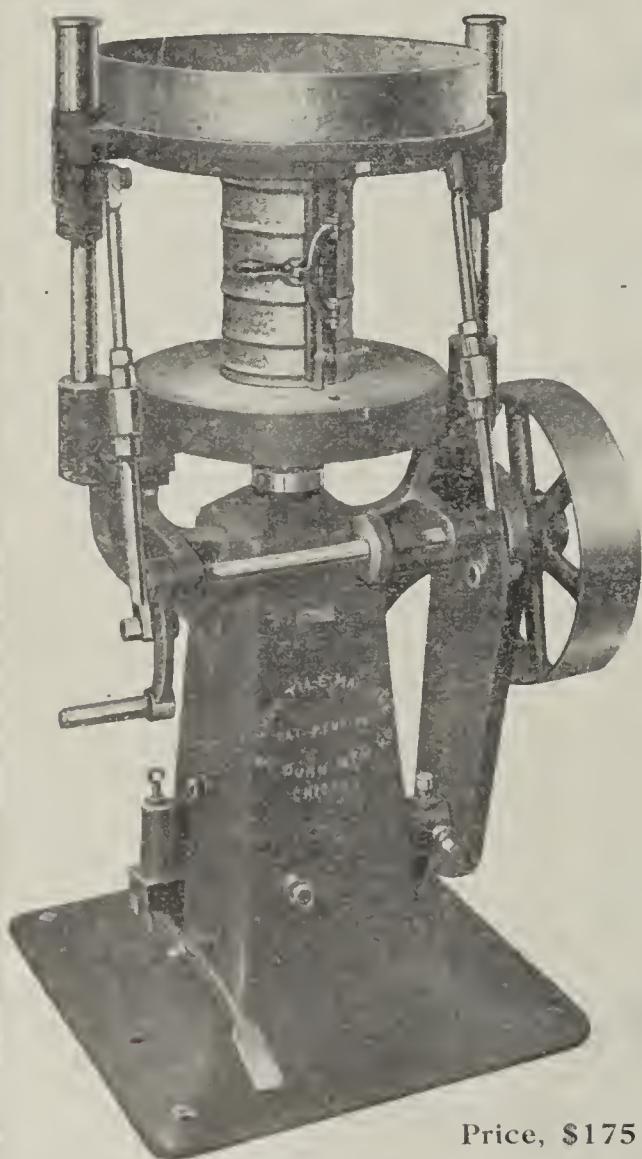
The Newaygo Portland Cement Company, which has office in Grand Rapids, Mich., and a plant at Newaygo has changed its name to the Grand Rapids Portland Cement Company.

Base, Basse & Broecking, of Fredericksburg, Tex., have purchased the cement block and brick plant of F. D. Grobe & Son.

The Kansas Portland cement plant, Iola, Kans., closed down this morning for an indefinite time. For the past few weeks the east portion of the plant has been the only active department. No information was given the employees as to how long the plant would be idle.

A large blast was set off at the quarries of the Corona Rock Company, Corona, Cal., on March 11. About 130,000 tons of rock were broken out by 30,000 lbs. of Judson R. R. P. and 3,000 lbs. of the DuPont company's 60 per cent dynamite. The explosives, according to the "Mining and Scientific Press," were placed in the ends of five drifts from a main tunnel driven into the side of the hill. The overburden above tunnel level was about 80 feet. The dynamite, according to the "Mining and Scientific Press," was used to detonate the Judson powder which furnished the force to shatter the rock. The charge was fired electrically after galvanometer tests on connections.

Arthur Cox resigned his position as superintendent of the Dewey Portland Cement Co. He is now living at Elk Rapids, Mich., and is not employed by any cement company as yet.



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This machine makes all sizes of cement tile from 3 to 12 inches. It makes 1,800 to 2,000 tile per day of 10 hours with two men operating.

It is built from the ground up. There are no bolts to work loose and no shaft can get out of line. All working parts are enclosed in the heavy cast iron base, perfectly protected from dust and sand. Even the chain is protected by a solid guard.

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Table of machine 34 inches high. Just the right height for operator.

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CEMENT

... AND ...

ENGINEERING NEWS



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for the advancement of
commerce and industry
is universally
acknowledged.

The Cement Shows have become fixed institutions for the development of the industries related to the use of concrete. The exhibits of representative concerns make the Shows the national markets for the cement industry.

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is complete without a display at these Cement Shows. They come during the opening of the season; they are held when contractors are planning to purchase supplies and equipment—when active work is light, affording time for thoughtful study of contemplated purchases.

The Cement Shows offer opportunity for the personal cultivation of buyers and for the actual demonstration of material and machinery.

The systematic and intelligent following up of prospects at past Shows have in many instances made possible the full operation of manufacturing plants during the year.

The Expense of Representation

at the Shows is slight in comparison with the cost of sales campaigns with the exhibition feature omitted.

Architects Contractors

engineers, builders and material dealers are becoming increasingly cognizant of the value to them of these Cement Shows as market places for the examination and purchase of supplies, machinery and equipment.

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72 W. Adams Street
Chicago

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

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Advertising copy or changes in ads. must be in this office by the 25th of each month, as hereafter our magazine will appear on the 5th of the following month.

Advertising Rates Sent on Application

JOHN F. WALDRON - - - - - Advertising Manager

CHICAGO, NOVEMBER, 1911

IMPROVED PORTLAND CEMENT.

In our May, 1910, editorial, entitled, "Reasons for Developing Our Large Resources of Natural Puzzuolana," we invited the co-operation of American engineers and chemists for the purpose of publishing all efforts made up to that time in testing and proving the value of natural puzzuolanas found in this country.

We did not know then that puzzuolana was being used also in the United States as an admixture to Portland cement on as large a scale as the publications of Mr. Duryee (Cement & Engineering News, January, 1911, page 12) and of Mr. Lippincott (Cement & Engineering News, May, 1911, page 174), the engineers of the Los Angeles Aquaduct, soon proved to be the case.

Foreign engineers who traveled through this country studying the American manufacturing processes of cement and application of concrete have frequently made the remark that the East possessed the largest cement plants and the greatest hustlers in the field of producing and marketing cement, but that the best equipped plants and the most intelligent engineers are to be found in the western States. Most likely this is due to the high price which Portland cement commands on the Pacific Coast, where consequently talent is employed in all phases of manufacturing and applying cement regardless of cost. The eastern cement manufacturer is often too conservative and at times even stubborn and will insist upon pure Portland cement being the most valuable mortar material in every instance. The western man, who is more of a student, is impartial and gives everything that comes to his knowledge a fair test. The latter principle undoubtedly creates better results. Therefore, the progressive western country will soon be far ahead of the East in scientific methods of utilizing cement materials.

Moreover, the West, with its numerous extinct volcanoes, is fortunate enough to possess large deposits of puzzuolana material which, if used as an ad-

mixture to Portland cement, cheapens the cost of concrete work and, at the same time, increases the resistance of the cement to the mechanical and chemical influences of the water.

While Cement & Engineering News, for a long time, made it a point to present to the American cement world translations of valuable European papers on the practice of puzzuolana admixtures to cement, as for instance Mr. Feret's excellent publication, "Resistance of Cement to Sea-Water Increased by Admixtures of Puzzuolana," in January, 1910, page 11, most of our contemporaries begin only now to mention the widespread use that has been made of natural and artificial puzzuolanas in Europe during the past 30 years.

Natural puzzuolanas have mostly been found to be superior to artificial puzzuolanas, that is to say granulated blast furnace slag. We, therefore, share the opinion of several editors of technical magazines to the effect that an admixture of blast furnace slag to Portland cement had better not be practiced in this country. Most blast furnace slags are very unreliable because they frequently change in composition and because of their high contents of alumina. On the other hand, we can not too highly recommend the admixture of natural puzzuolanas, volcanic products which, upon careful testing, have proven to be uniform in composition and have given results not only "just as good," but far superior to pure Portland cement, as for instance the puzzuolana described on the following page under the heading "Portland Cement Reground With Oregon Puzzuolana."

IOWA ASSOCIATION OF CEMENT USERS.

Arrangements are being made for the eighth Convention and Show, to be held in Sioux City, January 10, 11 and 12, 1912. This event goes to a section of the State this winter that is largely virgin territory from the cement standpoint. Sioux City is Iowa's second city and is so located as to attract cement users from Nebraska, the Dakotas and from Minnesota, besides all of Iowa. These neighboring states are all wide-awake and the rapid increase in the use of cement that is taking place should make them a mecca for the sale of cement and all cement using appliances. Sioux City is the business center of this rich territory and the Iowa Show will be the only event of this kind, to reach it this year.

Railroad facilities could scarcely be better. Trunk lines of the C. & N. W., the C. M. & St. P., the Illinois Central, the C. St. P. M. & O. railways, and a branch of the Great Northern all reach Sioux City. A large amount of cement paving is now under way and the city possesses some examples of concrete construction that cement men will come far to see. An entire packing plant of reinforced concrete is one of these attractions.

An instructive program is under way. It will include pictures, discussions, papers, addresses. The Show and Convention will both begin Wednesday, the 10th, and will close Friday night, January 12th, three days of pleasure, instruction and vacation.

Full information about the meeting may be had by writing the Secretary, Ira A. Williams, Ames, Iowa. Those wishing to join the Association should send the one dollar membership fee to the Secretary at once. This will entitle you to all the privileges of the Convention and Show.

The Show will be in the main city Auditorium, a structure admirably suited for the purpose.

Portland Cement Reground with Oregon Puzzuolana

By Dr. W. Michaelis

Recent publications* have shown that the American engineer is not slow in adopting the custom of the European builder with regard to the application of Portland cement containing admixtures of puzzuolana.

As almost everything in this country is done on a large scale, if compared with European practice, it will not surprise the reader to learn that in one of the first constructions in which puzzuolana-Portland cement was used in this country, namely, the Los Angeles Aquaduct, 400,000 barrels of cement were consumed and that this was achieved at a saving of about \$300,000; that is to say the amount of cement that went into the construction work would have cost three hundred thousand dollars more, if pure Portland cement would have been used instead of a mixture of puzzuolana and Portland cement.

The prejudice that formerly existed against the use of puzzuolana admixtures has been definitely overcome. This is true to such an extent that, several years ago, the German Government** declared cement containing admixtures of up to 30% of a natural or artificial puzzuolana to Portland cement to be fully equal to pure Portland cement, a decision which was the outcome of elaborate experiments carried on for a period of 30 years. The Los Angeles engineers, therefore, knew from the experience gained in Europe that the regrinding of Portland cement with a natural puzzuolana would assure them of results at least equal to those obtained with pure Portland cement and that it would, at the same time, considerably reduce the cost of the cement.

As, furthermore, the available literature proves that an admixture of puzzuolana to Portland cement increases the resistance of the cement to sea-water and to similar salt solutions, engineers and contractors are now fully aware of the advantages that accompany the application of Portland cement reground with puzzuolana and are prepared to make the widest use of it in the future.

The West will be an especially fruitful field for the manufacture of puzzuolana-Portland cement on account of the high price of cement. The cost of quarrying, crushing and marketing the puzzuolana amounts to very little, especially if the puzzuolana deposits are located near the water, as for instance in the case of a large deposit on the Columbia river, a few miles east of Portland, Oregon, a property which promises to become for the North Pacific coast the manufacturing center of an industry similar to that on the Los Angeles Aquaduct.

In the course of the past two years, the writer made extensive experiments with a view to establishing the value of the volcanic products to be found on this property and is in a position to demonstrate in the following that these materials are equal to the best puzzuolana occurring anywhere. At the same time, he

wishes to describe what tests are needed to prove the cementing qualities of a natural or artificial puzzuolana and to overcome the prejudice of years gone by against regrinding of Portland cement and puzzuolana, an opinion which owed its origin to a faulty method of testing.

The object of an admixture of puzzuolana to Portland cement is to retard or prevent the disintegration of the latter. The chemical ingredients making up the calcined product which we call Portland cement are high-limed compounds of lime, or calcium oxide, with silica, alumina and iron oxide. Upon addition of water to the powdered Portland cement, the finest particles are decomposed at once into their constituents, calcium hydrate on the one hand, and silica hydrate, alumina hydrate and iron hydrate on the other, which in time may chemically combine and form new hydrated salts, containing less lime than the original cement clinker, or may act one upon another merely in a mechanical way, namely by precipitation on their surface of a certain amount of hydrated lime. Whatever the case may be, the advocates of both theories must admit that a large part of the lime contained in the calcined product, which is liberated under the action of the water, subsequently never enters into any combination. It forms hydrated lime, or calcium hydrate, a soluble substance, which is easily dissolved by the water and carried away, rendering the concrete porous, or which precipitates, in sea-water or refuse water of mines, both of which contain a high percentage of sulphates, calcium sulphate, a substance which causes great damage to the cement by crystallization as such or after previous combination with the alumina compounds of the cement.

An admixture of puzzuolana to Portland cement counteracts both, the dissolving process of the water, which leads to a porous mortar that gradually admits the water to the inside of the most massive constructions, and the entering of the calcium hydrate into harmful chemical combinations. This is accomplished by offering to the surplus lime of the cement, for chemical or mechanical combination, identically the same substances with which, say half of the lime contained in the cement clinker is able to combine, namely silica hydrate, alumina hydrate and iron hydrate. Thus all of the hydrated lime of the decomposed cement is forced into combination and the cement, therefore, no longer exposed to the detrimental results caused by uncombined hydrated lime.

These desired hydrates of silica, alumina and iron oxide are found in nature in the form of puzzuolanas, or tufas, volcanic products created by the action of water or steam upon basaltic or granitelike molten formations. They can be artificially obtained by running molten blast furnace slag into water. In both cases the original compounds of the basalt, granite or slag are completely decomposed into their constituents and, furthermore, transformed into comparatively loose material which can easily be crushed. The most valuable part of the various chemical ingredients to be found in a natural or artificial puzzuolana is the silica hydrate, so-called "soluble" silica which, in distinction from quartz silica, powdered quartz, is soluble in a 10 per cent solution of sodium carbonate. Such silica combines readily with calcium hydrate and forms an excellent hydraulic cement. To what extent

*See Cement & Engineering News, January, 1911, page 12, "Improved Hydraulic Cements; Portland Cement Reground With Tufas;" and Cement & Engineering News, May, 1911, page 173, "Tufa Concrete."

**See Cement & Engineering News, January, 1910, page 11, "Resistance of Cements To Sea-Water Increased by Admixtures of Puzzuolana;" and Engineering News, September 7, 1911, "An Official Recognition of Puzzuolana Admixtures To Portland Cement Clinker."

the alumina hydrate and iron hydrate combine with calcium hydrate has not been definitely ascertained. However, from recent researches it appears that especially the alumina hydrate is able to combine with a very large percentage of hydrated lime.

As the substance serving as puzzuolana must combine and harden with hydrated lime, one of the first steps in the examination of a volcanic product, supposed to possess hydraulic properties, therefore, is to test a mixture of the finely pulverized material with powdered slaked lime for its cementing properties. Such a mixture is called a lime-puzzuolana cement, the only cement known to the ancient Romans and used by them extensively in the construction of their famous aquaducts which are partly preserved to the present day. Their main source of supply in Italy were the volcanic ashes at the foot of Mount Vesuvius in the neighborhood of the town Puteoli or Puzzuoli, from which is derived the name "puzzuolana." In Germany, along the Rhine, the Romans accomplished the same excellent results with the volcanic lava of the Eiffel Mountains, a puzzuolana called "trass" nowadays, which has been and is being used in enormous quantities, in mixtures with hydrated lime as lime-

eruptions. It may be mentioned immediately that special tests carried on with a view to ascertaining the influence of this admixture of undecomposed basalt proved that the amount of it was nowhere excessive and that even the best results were obtained with that part of the puzzuolana which contained the largest percentage of it, because it contributed towards increasing the density of the material.

The following experiments, carried on for the purpose of studying the strength of lime-puzzuolana mixtures and of comparing them with pure lime mortar were made with two kinds of samples:

F. An average sample of several hundred pounds of puzzuolana taken from a dozen places along the front at intervals for a distance of about a thousand feet.

E. An average sample of several hundred pounds taken from the east side of the deposit which proved to contain a higher percentage (about 10%) of undecomposed basalt than the rest.

Briquettes of standard size were made in the proportions of 1 part of puzzuolana-cement to 2 parts of torpedo sand and kept in a damp atmosphere. The tensile strength results are given in pounds per square

TABLE I.
TENSILE STRENGTH RESULTS OF LIME-PUZZUOLANA MORTARS.

	I. 1 puzz. cement, 2 sand	II. 1 puzz. cement, 2 sand	III. 1 puzz. cement, 2 sand
F. 28 days	20 lbs.	40 lbs.	52 lbs.
3 months	82 "	63 "	146 "
6 "	105 "	114 "	160 "
1 year	126 "	150 "	174 "
E. 28 days	48 lbs.	90 lbs.	65 lbs.
3 months	101 "	150 "	163 "
6 "	150 "	175 "	175 "
1 year	154 "	185 "	177 "

puzzuolana cement or mixed with Portland cement as puzzuolana-Portland Cement, especially for dams, locks, reservoirs and all kinds of marine constructions.

Hence, the first tests made with the Oregon puzzuolana in question consisted of lime-puzzuolana mixtures. However, before giving the results of these tests, a few words must be said about the location and composition of the deposits.

Surroundings, physical nature and chemical composition prove the puzzuolana occurring on this property to be of basaltic origin. Almost all mountains in the vicinity are composed of basalt. The loose friable mass of chocolate color, owing to a high percentage of iron oxide, was originally undoubtedly a colloidal sediment formed by the action of water upon the molten basalt flowing down the mountain sides. Possibly the volcanic lava originated from mountains nearby; however, it is just as likely that the seat of the eruption was farther up the river and that the current washed the decomposed basalt down stream and deposited it at this place several hundred feet high. Drying-out and pressure hardened the mass subsequently. All parts of the deposit contain fragments of undecomposed basalt imbedded in the puzzuolana proper, some more, some less, reminding the investigator of the rain of cinders and stone accompanying all volcanic

eruptions. Each figure represents the average of five tests. (See table I).

The "puzzuolana-cement" part of these mixtures consisted in the case of:

No. I. of 1.5 parts of hydrated lime to 1 part of puzzuolana.

No. II. of 1 part of hydrated lime to 3 parts of puzzuolana.

No. III. of 1 part of hydrated lime to 3 parts of puzzuolana.

In No. I. and No. II. the puzzuolana was ground to a fineness of 85% passing a 200-mesh sieve and in No. III. all of the puzzuolana passed a 200-mesh sieve.

The hydrated lime was passed through a 100-mesh sieve in all instances.

A comparison of these figures (table I.) with pure lime mortar of the same proportions, 1 part of hydrated lime to 2 parts of torpedo sand, for which the following figures were obtained:

Lime Mortar	
1 hydrated lime, 2 sand.	
28 days	None
3 months	46 lbs.
6 months	55 lbs.
1 year	55 lbs.

shows that the lime-puzzuolana mortars obtain about 3 times the strength of the lime mortar; hence that the volcanic product in question combines with hydrated lime and that the mixture results in a hydraulic cement, which can be kept under water, whereas pure lime mortar is softened and goes to destruction in water.

The next series of tests consisted of puzzuolana-Portland cement briquettes. The puzzuolana used for this purpose corresponded with the former sample "F," that is to say it represented a fair average of the front of the deposit.

In order to compare several mixtures of puzzuolana and Portland cement with pure Portland cement (Portland cement without admixture) and, furthermore, to compare the puzzuolana with an inert material (quartz sand), the following four sets of tensile strength tests were made, in which the "cement" part was composed of:

- I. Pure Portland cement.
- II. $\frac{3}{4}$ Portland cement, $\frac{1}{4}$ puzzuolana, mechanically mixed.
- III. $\frac{1}{2}$ Portland cement, $\frac{1}{2}$ puzzuolana, reground.
- IV. $\frac{1}{2}$ Portland cement, $\frac{1}{2}$ quartz sand, reground.

ment mixtures, because it makes the densest mortar of the highest specific gravity. However, as cement is never used neat, without sand, the neat tests are of no consequence and show only once more what faulty conclusions with regard to the relative value of a material as a mortar are frequently arrived at in cases in which only neat briquettes are made. Therefore, modern rules for testing cement describe sand tests only, as these alone are in a position to throw light upon the cementing qualities of a material.

The more sand is added to the cement, that is to say the more closely actual working conditions are approached, the sooner the puzzuolana-Portland cement mortars equal in strength the pure Portland cement mortars. In the case of 1 cement, 3 sand briquettes, No. II. and III. equal No. 1. only after 3 months; but for the 1 cement, 5 sand briquettes, No. I. II. and III. are equal from the very beginning.

The low strength obtained with the mortars resulting from No. IV. shows, better than anything else, the advantage of the puzzuolana admixture over any inert material ground to the same fineness.

Moreover, upon breaking the sand briquettes of the puzzuolana-Portland cement mixtures, the briquettes,

TABLE II.
TENSILE STRENGTH RESULTS OF PUZZUOLANA-PORTLAND CEMENT MIXTURES.

	I. Pure Portland Cement	II. $\frac{3}{4}$ Portland $\frac{1}{4}$ Puzzuolana mixed	III. $\frac{1}{2}$ Portland $\frac{1}{2}$ Puzzuolana reground	IV. $\frac{1}{2}$ Portland $\frac{1}{2}$ Quartz Sand reground
NEAT CEMENT BRIQUETTES				
7 days	804	469	305	394
28 "	925	669	426	499
3 months	967	778	475	634
1 year	970	795	615	642
1 CEMENT, 3 SAND BRIQUETTES				
7 days	333	266	225	191
28 "	419	375	338	291
3 months	477	495	465	394
1 year	574	556	566	453
1 CEMENT, 5 SAND BRIQUETTES				
7 days	156	165	140	90
28 "	215	238	250	188
3 months	314	371	374	291
1 year	438	453	497	367

Before grinding took place, 85% of the Portland cement and the same amount of the puzzuolana passed a 200-mesh sieve. After having been reground the mixture possessed a fineness of 95% passing a 200-mesh sieve. The respective fineness was the same in the case of the quartz sand before and after regrinding.

Each figure represents again the average of five tests and gives the tensile strength in pounds per square inch. All briquettes were kept in water. (See table II.)

These tests show that, in the case of briquettes made without torpedo sand (neat cement), No. I., pure Portland cement, is the highest, but that, in the sand tests (1 cement to 3 sand and 1 cement to 5 sand), the pure Portland cement, No. I., is soon surpassed by the puzzuolana-Portland cement mixtures, No. II. and No. III., whereas No. IV., in which quartz sand was substituted for puzzuolana, invariably stayed far behind.

Tested as neat cement, the pure Portland cement has an advantage over the puzzuolana-Portland ce-

when only a few weeks old, were found to have a dry core, showing the high degree of imperviousness due to puzzuolana admixture, whereas both the pure Portland cement sand briquettes and those made with mixture No. IV. were moist throughout at all periods of testing.

The object of the next tests was to demonstrate the value of the puzzuolana-Portland cement mixtures also in compression. For this purpose, six-inch concrete cubes in mixtures of 1 cement, 2 sand, 4 crushed stone (1:2:4) and of 1 cement, 3 sand, 6 crushed stone (1:3:6) were made. These were kept in air up to 7 days and were submerged in water after that time.

The "cement" part of these concrete mixtures consisted in the case of:

- A. Of: Pure Portland cement.
- B. Of: $\frac{2}{3}$ Portland cement, $\frac{1}{3}$ puzzuolana, reground.
- C. 1. Of: $\frac{1}{2}$ Portland cement, $\frac{1}{2}$ puzzuolana, reground.

C. 2. Of: $\frac{1}{2}$ Portland cement, $\frac{1}{2}$ puzzuolana, reground.

C. 1 and C. 2 contained the same amount of Portland cement and puzzuolana. However, in the case of C. 1, the Portland cement was reground with finely ground puzzuolana and in the case of C. 2 it was reground with coarse puzzuolana. As ultimately both mixtures had the same fineness, the Portland cement part in C. 2 had been ground for a longer time and was finer than that in C. 1.

Each figure represents the average of five test cubes and gives the compression strength in pounds per square inch (see table III.).

These results show that the puzzuolana-Portland cement mixture "B," containing $\frac{2}{3}$ Portland cement and $\frac{1}{3}$ puzzuolana, is equal in strength to pure Portland cement "A" from the very beginning and surpasses it after a month. This is the mixture customarily used in Europe and by the German Government declared to be fully equal to pure Portland cement.

Furthermore, we learn from table III., that the puzzuolana-Portland cement mixtures "C. 1" and "C. 2," composed of equal parts of Portland cement and puz-

be compared with those given under "A" in table III., which latter may be repeated in order to facilitate a comparison.

Also here the advantage of the substitution of puzzuolana for part of the sand becomes fully apparent only in the lean mixture 1:3:6 which will continue to increase in strength and will, in the future, surpass concrete "A" even more than it did after 3 months.

In addition to the old-time practice of testing of neat cement briquettes and of cubes of concrete mixtures very rich in cement, both of which did not correspond with actual working conditions, a common mistake in testing puzzuolana-Portland cement mixtures consisted in allowing the small test pieces to rapidly dry out in the air, whenever "air tests" were made. Consequently, most investigators admitted the equality or even superiority of puzzuolana admixtures for all concrete work to be done under water or to be exposed to water shortly after being moulded. However, puzzuolana-Portland cement concrete which was permanently exposed to the air could, in their opinion, never reach the same high strength as similar concrete kept under water. This view was, for a long time, one of the most serious objections to the general

TABLE III.

COMPRESSION STRENGTH TESTS OF PUZZUOLANA-PORTLAND CEMENT MIXTURES.

	A. Pure Portland Cement	B. $\frac{2}{3}$ Portland $\frac{1}{3}$ Puzzuolana reground	C. 1. $\frac{1}{2}$ Portland $\frac{1}{2}$ Puzzuolana reground	C. 2. $\frac{1}{2}$ Portland $\frac{1}{2}$ Puzzuolana reground
1 : 2 : 4 C O N C R E T E				
7 days	778	722	443	290
28 "	1441	1470	991	997
3 months	2330	2427	1898	1770
1 : 3 : 6 C O N C R E T E				
7 days	406	373	303	259
28 "	861	896	769	778
3 months	1283	1359	1292	1325

zuolana, are somewhat inferior to pure Portland cement concrete in the 1:2:4 mixtures, but are fully equal in strength, or even superior, after 3 months in the 1:3:6 concrete. This fact likewise coincides with European experience which teaches that the advantage of puzzuolana admixtures becomes the more apparent the leaner the mortar or concrete. As exclusively lean concrete is used for massive constructions, as for instance dams, reservoirs, locks, sluices, and so forth, mostly 1:3:6 concrete or even 1:4:10, puzzuolana-Portland cement mixtures, composed of equal parts of puzzuolana and Portland cement, are, therefore, more widely used than mixtures richer in Portland cement. This refers particularly to natural puzzuolanas which give even better results than artificial puzzuolanas or granulated blast furnace slags. Of the latter kind of puzzuolana an admixture of 30% is rarely exceeded.

Another set of compression strength tests ("D") was made with the regular pure Portland cement concrete mixtures 1:2:4 and 1:3:6. However, in this instance $\frac{1}{2}$ part of the sand was replaced by an equal part of finely ground puzzuolana, which was merely mixed with the cement, sand and crushed stone before making the concrete. Hence, these concrete mixtures are in fact 1:1 $\frac{1}{2}$: $\frac{1}{2}$:4 and 1:2 $\frac{1}{2}$: $\frac{1}{2}$:6 mixtures. As the "cement" part is composed of pure Portland cement, the figures given under "D" in table IV. must

use of puzzuolana-Portland cement concrete. It was declared to be absolutely faulty only after it had been demonstrated by carefully conducted tests under conditions prevailing in practical operation that concrete foundations, walls, columns, and even more so, constructions of larger proportions, never dried out as rapidly as small laboratory test pieces exposed to the air and that by the time the concrete loses most of its surplus water the puzzuolana has so well combined

TABLE IV.

CONCRETE IN WHICH PART OF THE SAND IS REPLACED BY PUZZUOLANA.

	A. Pure Portland Cement	D. Pure Portland Cement
1 : 2 : 4 CONCRETE		1 : 1 $\frac{1}{2}$: $\frac{1}{2}$: 4 CONCRETE
7 days	778	522
28 "	1441	1288
3 month	2330	2258
1 : 3 : 6 CONCRETE		1 : 2 $\frac{1}{2}$: $\frac{1}{2}$: 6 CONCRETE
7 days	406	390
28 "	861	857
3 months	1283	1545

with the hydrated lime, liberated during the hardening of the Portland cement, that subsequently no decrease in strength becomes noticeable.

It has been, therefore, agreed upon that small test pieces, briquettes or cubes, representing "air tests" have to be kept in a moist atmosphere. If this is done, puzzuolana-Portland cement tests conducted in air and under water will always be found to be of equal strength, as table V. shows, in which mixture "B," 2/3 Portland cement, 1/3 puzzuolana, was made into 1:2:4 and 1:3:6 concrete cubes. In this instance a Portland cement was used which differed from that forming part of the concrete cubes "B" in table III. in as much as it was more quicksetting and consequently obtained a higher strength during the first periods of testing; this explains the difference in strength between the two series of concrete cubes "B" in table III. and V. Each figure is the average of five tests.

The experiments described in the foregoing show that the puzzuolana used in these tests results in a commercial product of excellent qualities, if reground with Portland cement in the proportions of 2 parts of Portland cement to 1 part of puzzuolana, or even of equal parts of both ingredients. The latter mixture has been found to be equal or even superior to pure Portland cement, both in tension and compression, in all lean mixtures, which correspond with actual working conditions. Richer mixtures are only rarely used, and should they be desired, the puzzuolana-Portland cement mixture will prove to be of especial advantage on account of the greater saving involved. In rich mixtures, the pure Portland cement has been found to be slightly superior in strength during the first months, but at the end of a year and at all subsequent dates, the puzzuolana-Portland cement mixtures mentioned are as a rule equal to pure Portland cement also in these rich mixtures.

In conclusion it may be mentioned that the sand-lime brick industry represents another field of usefulness for puzzuolana. Sand-lime products, which are steadily growing in favor with architects and builders, are generally made of mixtures of quartz sand and hydrated lime. This mixture is moulded and hardened by exposure to steam under high pressure and results in brick or ornamental blocks of the quality of the best concrete blocks. If, in these mixtures, part of the sand is replaced by ground puzzuolana, far superior results are obtained as can be seen from the literature on the subject.*

In the course of the past fifteen years, America has achieved wonderful results in the manufacture of Portland cement. During this period it revolutionized the process of cement burning by the invention of the rotary kiln process, produced Portland cement equal to the best European brands, which latter were used exclusively up to that time, and finally decreased the cost of production of Portland cement by practising economy in every department. As a result, the demand for cement has increased from year to year. Every improvement in the process of manufacture and reduction in cost meant a steady increase in the consumption of cement. This law will continue to govern production and consumption of cement. Each period in the manufacture and application of cement had its tasks which were gradually worked out. Those of the past have been enumerated in the foregoing; that of the near future will be a more economical and reliable

TABLE V.

COMPARATIVE TESTS OF SIX-INCH CUBES KEPT IN WATER AND IN AIR.

	B. Kept in Water	B. Kept in Air
1:2:4 CONCRETE		
7 days	1061	1106
28 "	1764	1807
3 months	2550	2518
1:3:6 CONCRETE		
7 days	634	632
28 "	938	918
3 months	1302	1349

application of Portland cement. This problem will be solved by admixtures of puzzuolana to Portland cement, which will safeguard the cement against decomposition, especially in sea-water, and will at the same time reduce the cost of concrete construction considerably.

CONCRETE FENCE POSTS.

That the manufacture of concrete fence posts can be made a successful business has been shown by the Acers Hollow Concrete Post Company, of Oklahoma City, Okla. This company make a hollow hexagonal reinforced concrete post, six feet in length, weighing fifty pounds. The posts are sold principally to the lumber trade in Oklahoma, who retail them to the users.

The posts are well made and substantial, and are said to have proven very successful in use. The manufacturers are carrying on an advertising campaign among the farmers of Oklahoma and it is said that quite a demand has been created for the posts by the aggressive and up-to-date selling methods of the manufacturers. The tests, observations and use of concrete fence posts during the current year indicate says a report of the Twelfth Annual Convention of the American Railway Engineering and Maintenance of Way Association.

(1) That concrete fence posts are practicable, durable and economical.

(2) The eight-foot post is recommended.

(3) Posts of cross-section approaching a square form are easiest made and most suitable for fencing.

(4) Spacing, same as recommended for wood posts.

(5) Stone or gravel used in mixing concrete for fence posts should pass a half-inch square mesh. Concrete should be mixed wet, in a batch mixer, and poured into the moulds. The poured posts are a little over 25 per cent stronger than tamped posts of the same size, mixture and reinforcement; they are also better able to withstand the action of frost and alkali. Experience shows that extra precaution should be used in the selection of material, mixing of concrete and handling and curing the posts. For the best results, posts should be allowed to remain in the yard undisturbed for at least sixty days after coming from the moulds.

(6) Breakage in handling and transportation should not exceed three-tenths of one per cent.

Conclusion: Concrete fence posts are recommended for railway fences.

*See Cement & Engineering News, September, 1911, page 292, table XXXI., Admixtures of Puzzuolana to Sand-Lime Brick.

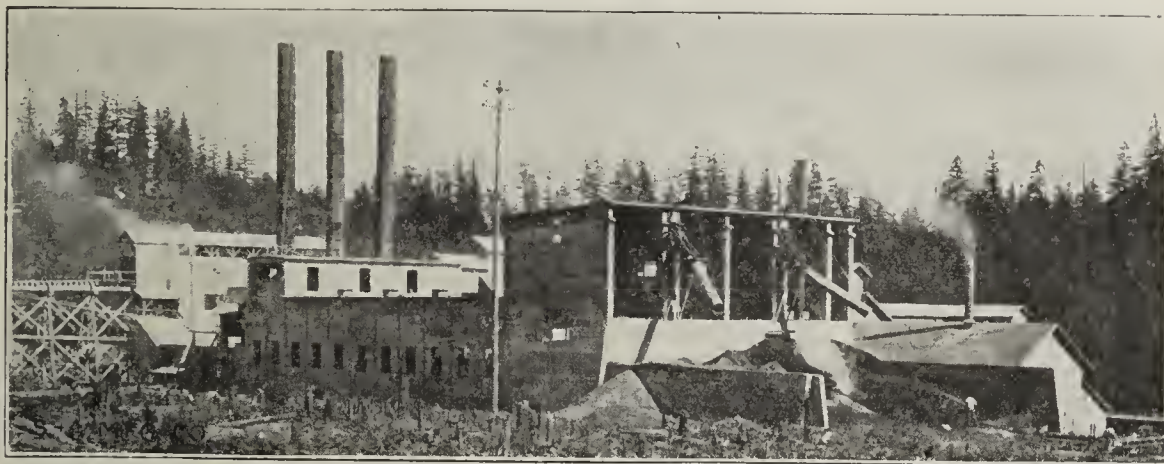
The Superior Portland Cement Co., Concrete, Wash.

By Paul C. Van Zandt

The Superior Portland Cement Company, located approximately one hundred and twenty miles north of Seattle on the Great Northern Railroad, at the foot of the western slope of the Cascade range of mountains, has the most interesting installations for getting their raw material from the quarry to the plant of any cement plant the writer has ever seen. The Superior Portland Cement Company is situated at Concrete, Wash., about one mile west of the point where the Baker river enters the Skagit. This plant and the Washington Portland Cement Company, located immediately east of the Baker river, are the only two producing cement plants in western Washington, and until this year, were the only two producing cement plants in the State.

Lime rock is comparatively scarce in Washington, but the few ledges that do exist are of enormous size and remarkable purity. For example, there is an enor-

or hung onto a vertical wall. At this point it crosses the river on a timber bridge the lower stringers of which were made from logs cut in the vicinity, from five to six feet in diameter and 90 feet clean span. The structure of this bridge is unique. There is an overabundance of timber, and in reality the bridge simply consists of a number of logs laid across the stream from one abutment to the other with a trestle built on top of them, there being no attempt to form either an arch or a truss. This is unquestionably a waste of timber, but the timber is to be had for the cutting and the labor problem is a serious one in the West and the cost of framing of a truss bridge would have been high. After crossing the river the railroad runs approximately east to a point as high up on the side of the mountain of lime rock as can be reached with a reasonable grade. At this point loading bins have been constructed as shown in one of the illustrations,



General View of Superior Portland Cement Plant, Concrete, Wash., Showing Reinforced Concrete Kiln Building, Clinker, Storage, etc.

mous ledge at Orcas Island, which has been the source of lime rock for the manufacture of lime upon a large scale for a great many years and is a veritable mountain of lime rock.

The ledge of lime rock which is quarried by both the Washington and Superior Portland Cement companies is another mountain or ridge running back from the river in a northeasterly direction for a number of miles: It is exposed near the Baker river apparently in the form of a dyke or ledge lying on edge and, where it is quarried by the Superior Portland Cement Company, rises to a height exceeding one thousand feet above the site on which the cement plant is located. The quarry is about two and one-half miles away from the plant and on the other side of the Baker river which at this point flows through a narrow gorge from three hundred to four hundred feet deep with vertical walls, and with a ledge of lime rock so high in an extremely mountainous country it can readily be seen that the problem of getting material from the quarry to the cement plant was a very serious one. This problem has been worked out in a remarkably efficient manner and the difficulties have been admirably overcome. In the first place, there is a railroad track running from the cement plant to as near the quarry as it could be properly located. This railroad runs through the town of Concrete and up along the west bank of the Baker river, gradually gaining height until it reaches a point at the narrowest place in the gorge approximately three hundred feet above the river. Up to this point it appears as though the railroad was cut

which are filled with rock from cars lowered down an incline gravity tram. This tram is about seven hundred feet long and three hundred and fifty feet high. There are two cars or skips operating in balance, the loaded car up being lowered, pulling the empty car back up the incline. The operator who runs this gravity tram stands at the top and permits the loaded car to descend by loosening a heavy band brake upon the upper sheave wheel.

The quarry is mined by what is known as the glory-hole process, as shown by the illustration. From the point where the skips above referred to are loaded, a tunnel has been driven into the lime rock for a distance of three hundred or four hundred feet and an upraise driven to the surface at the top of the mountain. This upraise is set on one side of the tunnel and the lower end is closed up with timber provided with gates. In the operation of the quarry, rock is quarried at the top around this hole and runs to the center of the quarry pit in which the upper end of the upraise is located, filling the upraise completely. The rock is then drawn through the gates at the lower end of the upraise into cars which are run out to the mouth of the tunnel and dumped into a hopper over a tippie, which hopper feeds the skips on the incline gravity tram.

The upraise which now constitutes a rock chute is kept filled with rock all the time and as fast as any is drawn out from the bottom, a corresponding amount is quarried at the top. There is no danger, therefore, of either men or pieces of rock too large to be handled, falling into the rock chute.

Should the rock "bridge" at the lower end of the chute and not flow properly through the gates into the cars there is a by-pass large enough for a man to enter to one side of the rock chute connecting with the tunnel. The rock as quarried thus is drawn into cars at the bottom of the chute much in the same way as sand in an hour glass.

It would be a difficult thing to quarry this rock on an open face on account of the enormous proportions that it would acquire with the result that when a blast was made the rock loosened from the top of the quarry face would not stop at the quarry floor, but continue rolling down the hill to a point where it would not be easy to load it. As a matter of fact, in the early operation of the quarry before the gloryhole was installed, this actually happened on one occasion.

The trainmen that come up from the cement plant load their own cars. The railroad is operated by electricity furnished by water power. The air compressor for the drills in the quarry is supplied with power by the same current.

The clay used in the manufacture of cement is secured from the west bank of the Baker river and is of excellent quality. It is spouted from the clay quarry into the cars upon the railroad track, the railroad running immediately past the clay deposit.

The clinker leaving the kilns is elevated and spouted to storage from which it is drawn by a pan conveyor to a rotary cooler, which may be operated as a dryer in case wet clinker is drawn from storage. The clinker is pulverized in a Sturtevant Ring Roll Mill, manufactured by Sturtevant Mill Co., Boston, Mass.,



Upper end of gravity tram, looking towards quarry of Superior Portland Cement Co. View taken before rails were laid.

Timber Bridge across Baker River, for railroad carrying rock, from quarry to cement plant.

View showing rock bunker at bottom of incline gravity tram, where rock is delivered to railroad cars for transportation to plant.

View showing construction of bridge across Baker River, consisting of high trestle supported on logs thrown across river, with a 90 ft. clear span.

The only way to start a quarry in a mountain of lime stone as large as this, where operations for a number of years is probable, is to start at the top, because if operations are started at the base or anywhere along the slope, it is only a question of time before the quarry face would become as high as the mountain rises above the quarry floor, which is virtually an impossibility to work, or else mining operations are necessary. The gloryhole, therefore, seems to be by all odds the best way out and possesses a great many advantages. There are no tracks in the quarry to be moved before blasting, no hand loading of cars, no long haulage system. The only disadvantage of any consequence that the writer can see, is the necessity of breaking the rock up by hand sledges in the quarry to a size that will handle in the chute and through the gates. It takes about two men to handle the rock from the chute to the tipple and one man to handle the gravity tram.

and P. & M. Ball Tube Mills, followed by Tube Mills. All the elevating and conveying machinery in the plant was furnished by the Stephens-Adamson Manufacturing Company, Aurora, Ill.

The plant is driven by water power from a stream entering into the Baker river about seven miles from the plant. The power is transmitted from the location of the power house on this stream in the form of a high tension electric current, which is transformed at the plant to 440 volts, 60 cycle. During the past year an auxiliary power plant was installed at the cement plant proper consisting of a couple of waste heat boilers back of the kilns and a "St. Louis Corliss" engine driving a generator.

When construction work was started upon this plant about four years ago, it was necessary to clear away the timber from the tract of ground upon which the plant was built and more than enough timber was cut to entirely build the plant. A certain portion of it is,

therefore, made of wood, as has been the custom on the coast, but the kiln room is made of reinforced concrete and is a model of its kind in this respect. The market for the product is principally the territory west of the Cascade range from the Canadian border to Portland, Oregon. A certain amount of cement is shipped into the desert country east of the mountains, a large portion of which has been used for irrigation projects.

It is a remarkable fact that this cement plant located in a forest in a country where timber is the cheapest thing to be had should be replacing with its product this cheap timber. The fact remains that Portland cement is going into all the permanent installations on the West coast at the present time. The city of Seattle alone has a great many reinforced concrete buildings and practically no wooden buildings in the downtown portion.

CEMENT INDUSTRY IN 1910.

An Increase of Ten Million Barrels Over 1909 Shown by Figures of the U. S. Geological Survey—Largest Production in the East.

The statistics of cement production in 1910, as reported by Ernest F. Burchard, of the United States Geological Survey, indicate that the cement industry ranks within the first eight extractive industries in the United States, the value of the cement produced being exceeded only by the value of the coal, pig iron, petroleum and gas, clay products, copper and stone.

On the first of January, 1911, according to responses to telegraphic requests sent by the Survey to the larger cement companies, it was apparent that the Portland cement industry had made a new high record in 1910, and it was then estimated by Mr. Burchard that the production for the year might reach 75,000,000 bbls. Few other estimates ventured beyond this limit, and that it has been exceeded by more than half a million barrels, as is shown by the following statistics, will doubtless prove surprising to nearly everyone closely in touch with the cement industry.

The total quantity of Portland, natural and puzzolan cements produced in the United States during 1910 was 76,934,675 bbls., valued at \$68,052,771. Compared with 1909, when the production was 66,689,715 bbls., valued at \$53,610,563, the year 1910 showed an increase of 10,244,960 bbls., or 15.3 per cent, in quantity, and of \$14,442,208, or 26.9 per cent in value. The increase in quantity is one of the largest ever recorded, and the fact that the increase in value was proportionately higher indicates that trade conditions were slightly more satisfactory than during 1909.

Twelve Million Tons of Portland Cement.

The total production of Portland cement in the United States in 1910, as reported to the Geological Survey, was 75,699,485 bbls., valued at \$67,506,479. This quantity reduced to tons is equivalent to 12,841,430 long tons, valued at \$5.26 a ton. Compared with the output of pig iron for 1910, which was 27,298,545 long tons, having an estimated value of \$419,851,622, or \$15.38 a ton, the production of Portland cement approximates 47 per cent of the quantity of pig iron and 16 per cent of its value. In 1909 the production of Portland cement was 64,991,431 bbls., valued at \$52,858,354; the output for 1910; therefore, repre-

sents an increase in quantity of 10,708,054 bbls., or 16.5 per cent, and in value of \$14,618,125, or 27.7 per cent. The average price per barrel in 1910, according to the figures reported to the Survey, was a trifle less than 89.2 cts. This represents the value of the cement in bulk at the mills, including the labor cost of packing but not the value of the sacks or barrels. This average price is 16.5 cts. higher than the average price received for cement in the Lehigh district, 14.2 cts. higher than that in the Eastern States, 1.8 cts. lower than that in the Central States, 13.8 cts. lower than that in the Western States, 4.8 cts. lower than that in the South, and 48.8 cts. lower than that on the Pacific coast. In the average price for the country is included the value of nearly 75,000 bbls. of white Portland cement which sold for an average of \$2.86 a barrel.

CONCRETE PROTECTION COATING FOR A SMALL TANK TOWER.

(From Engineering News.)

A 60-ft. tower supporting an elevated tank in the residence colony of the Highland Summer Club, at White Bluff, Tenn., was recently protected with a concrete casing of the posts and struts because of rather rapid rusting. The work proved simple and remarkably cheap. The tank and tower were built in 1902. Rusting went on, in spite of frequent cleaning and painting, until in the fall of 1910 strengthening or other treatment was required. The tower was still strong enough for safety, but it was evident that some means of checking the progress of deterioration and rusting up the lost strength was desirable. The four tower legs were composed each of four 3½ by 3½ by ¼-in. angles, riveted in star shape, and the struts of two angles of the same size, riveted back to back. The legs were not much rusted, but the struts had suffered badly, as the stitch riveting was widely spaced and the water entering the joint caused the angles to be forced apart by the rust. Hunter McDonald, chief engineer of the Nashville, Chattanooga & St. Louis Ry. and president of the club, had to decide upon the most suitable way of dealing with the case. He concluded that the cheapest and best method was to encase all of the tower except the diagonal bracing with concrete. This was carried out.

The columns were wrapped spirally with No. 9 steel wire on a pitch of 3 ins. The struts were similarly wrapped, and in addition, two ¼-in. rods were placed horizontally under each strut. The forms for the columns were built up in heights of 4 ft., and it was found that this permitted thorough filling and ramming of the concrete. Small diagonal corner angles in the horizontal plane between adjoining struts were also encased in concrete. The diagonal rods are not specially bonded where they pass out of the concrete filling between post and strut. The concrete covering has outside dimensions of 10 by 10 ins. for the posts and 6 by 8 ins. for the struts. The total work cost \$200, which is equivalent to about \$10 per cu. yd. of concrete in place.

BIG WATERPROOFING ORDER.

On August 31, the Ceresit Waterproofing Co., of Chicago, shipped to Los Angeles, Cal., 10,000 pounds of Ceresit waterproofing, to be used in waterproofing the foundations of the new "Times" Building that will replace the structure recently wrecked by explosion.

Power and Heat Distribution in Cement Mills

By J. L. Griffiths

This paper considers the methods employed in cement mills for converting the dormant thermal power of fuel into active and productive mechanical motion. It has been the good fortune of the writer to have been in direct charge of several manufacturing plants and data are given with reference to five cement plants which use the thermal power of fuel in different ways.

The primary means of developing this thermal power of a fuel is by means of the application of the heat evolved either by total or partial combustion. If by total combustion, the first means commonly employed for the first stage of the power transmission is steam, either saturated or superheated. The prime mover actuated by this steam, whether it be a reciprocating engine or a turbine, is the second step of the power transmission. Then we have the further transmission of this power through means of belted, geared or direct connection of this prime mover to a lineshaft, thence by means of further belts, gears, ropes or chains from the lineshaft to the machine finally operated. Or we have the prime mover actuating a generator from which the power in changed form is transmitted through wires to motors operating the machines either by direct connection or by means of lineshafting, belts, gears, ropes or chains.

Where the first stage is the partial combustion of the fuel resulting in the production of an explosive gas, the prime mover then is an internal-combustion engine connected similarly to that described above.

In considering the several plants as set forth in Table 1, a brief description is given both of the power installation and the mill arrangement, since there is a considerable difference of opinion as to which form of power consumption is the most economical type for crushing, grinding and pulverizing machinery.

The item of fuel herein considered as the source of power, is roughly 30 per cent of the manufacturing cost of a barrel of cement and each barrel of cement manufactured represents the conversion of from 2,000,000 to 3,000,000 B.t.u. Of this total amount, 25 per cent is used in the generation of power in the actual mechanical operation of the machinery of the plant, so that it may readily be seen that the means of converting and transmitting this power is worthy of study and consideration.

Plant No. 1 A 1000-Bbl. Plant Nominal Capacity.

When operating 100 per cent of the machinery 100 per cent of the time the daily output of plant No. 1 would be 1,000 bbl. of Portland cement. Briefly, its general arrangement is as follows: Stone from the quarry in man-size pieces is crushed in a gyratory crusher, dried in a rotary drier, further reduced in rolls and finally pulverized in Fuller mills. The raw material is burned in rotary kilns, and the cement clinker prepared for pulverizing by passing through toothed crushers and pulverized in 30-in. Griffin mills.

The boiler equipment of the power plant consists of three horizontal tubular boilers of 75 h. p. each, four horizontal tubular boilers of 100 h. p. each and one B. & W. water tubular of 340 h. p. The ash-pits of all the boilers are equipped with McClave steam blowers with steam pressure at 100 lb. They are using West Virginia bituminous slack or run of mine, but its use is uneconomical because the grates are set for hard coal. About 60 per cent of the raw end of this plant is driven by an 18-in. by 40-in. Wright non-con-

densing engine and the balance or 40 per cent of the raw end, and 100 per cent of the finishing end, is driven by a 20-in. and 34-in. by 42-in. tandem compound Corliss engine operating at 100 r. p. m. in connection with a jet-condenser and cooling-tower installation. The kiln room is operated by one 11-in. by 11-in. Buckeye non-condensing 150-r.p.m. engine. With this power installation the plant turns out a barrel of cement for 0.839 h.p.

Plant No. 2 A 1200-Bbl. Plant Nominal Capacity.

Plant No. 2 of 1200-bbl. nominal capacity, operates at an output better than 100 per cent because of the excellence of the operating force. The general arrangement is as follows: Stone from the quarry is crushed in gyratory crushers of the same make and size as in plant No. 1, dried in a rotary drier, also of the same make and size as in Plant No. 1, but the material is now ground in ball mills and is finely pulverized in tubemills, then burned in kilns of the same size as those of plant No. 1. The cement is prepared for pulverizing and is pulverized as in plant No. 1.

The boiler equipment of the power plant consists of eight double-drum elephant boilers each of 150-h.p. capacity. The furnaces are equipped with balanced-draft burning Buckwheat anthracite coal. The raw-end of this plant is driven by one 20-in. and 36-in. by 42-in. cross-compound condensing Corliss engine operating at 87-r.p.m. The finishing end is driven by a duplicate of this engine, and the kiln room is operated by one 11-in. by 18-in. Buckeye 150-r.p.m. non-condensing engine. The coal house, the handling, drying, crushing and pulverizing coal for kiln fuel is operated by one 11-in. by 10-in. vertical Westinghouse 230-r.p.m. steam engine, and one 20-in. by 16-in. Westinghouse 250-r.p.m. engine. This plant produces a barrel of cement on 0.835 i.h.p.

Plant No. 3 A 2000-Bbl. Plant Nominal Capacity.

Plant No. 3 is a more recently constructed plant than either No. 1 or No. 2 and is laid out in a somewhat better manner. This fact, together with a more efficient working force, results in an output better than the rated output of 100 per cent. The crushing, grinding and pulverizing machinery of the raw ends, kilns and auxiliaries of the burning department, and crushers and pulverizers of the finishing end, were the same as in plant No. 2, a greater number of the same size units being used for the increased capacity.

The boiler equipment of the power plant consists of seven 350-h.p. B. & W. boilers fired by Westinghouse stokers using anthracite pea coal, both coal and ashes being automatically handled by conveyors and elevators. The boilers are also equipped with super-heaters and the raw end is operated by one 20-in. and 40-in. by 54-in. cross-compound Corliss condensing engine of 74-r.p.m. The finishing end is operated by a duplicate of this engine, and the kiln room by one 16-in. and 28-in. by 42-in. tandem compound Corliss condensing engine at 85-r.p.m. The coal house is operated by one 12-in. and 24-in. by 42-in. tandem compound Corliss condensing engine of 80-r.p.m. This plant produces a barrel of cement on 0.777 i.h.p. The prime movers in every instance are belted to a main lineshaft, the individual machines being in turn driven from this lineshaft by belt, chain, rope or gear drives.

These three plants are known in the cement business as direct-driven plants: that is, in such plants the prime mover is belted to a lineshaft and the individual machines are in turn driven by belts, gears, chains, etc., from this lineshaft. Plants Nos. 4 and 5 are known as electrically-driven plants.

Plant No. 4 A 2000-Bbl. Plant Nominal Capacity.

Plant No. 4 with a nominal capacity of 2,000 bbl., although a comparatively new plant, has never been operated at better than 60 per cent of its nominal rating, due to a very poor arrangement of mixing, conveying and pulverizing machinery. On account of the load condition, however, the electrical efficiency is high in that the motors are operating at from 100 to 125 per cent full load; and the maximum efficiency of the induction motor is at about 120 per cent rated load.

The general arrangement of this plant is as follows: Stone in man-size pieces is reduced by passing it through two gyratory crushers; the shale is reduced by passage through toothed rolls. It is dried in a rotary drier, mixed with limestone and further reduced with it in a Williams' mill. The material is then passed through two rotary mix driers to 30-in. Griffin mills used as preliminaries to tube-mills, in which the raw material is finished. This is burned in kilns of the same size as those in the No. 2 and No. 3 plants. The clinker is prepared by passing through a toothed crusher and rolls, and pulverized in 30-in. Griffin mills.

The boiler equipment of the power plant consists of two 250-h.p. Cahall vertical boilers, four 250-h.p. O'Brien-Heine boilers, and one 375-h.p. O'Brien-Heine boiler. The fuel used is Southern Indiana bituminous coal and with the exception of the Cahall boilers, the setting and grates are for hard coal. The furnace efficiency is therefore low. The prime movers in this plant are two vertical Curtis turbines, one direct connected to a 1000-k.w. three-phase 25-cycle, 440-volt alternator, and the other to an 800-k.w. alternator. Each individual machine throughout the plant is driven by an individual motor of proper size by a belt from the motor pulley to a shaft and from the shaft to the machine either by gears, belt or chain drive. This plant consumed 1.26 h.p. per bbl. of cement produced.

Plant No. 5 A 2500-Bbl. Plant Nominal Capacity.

Plant No. 5 comes under the same heading as plant No. 4, but is unique in that it is the only one which starts with partial combustion of the fuel, and discarding steam as a means of power transmission between the fuel bed and the prime mover, uses the gas direct from the fuel in an internal-combustion or gas engine. Due to the difficulty of mixing and combining the raw materials of the section in which the plant is located it is operating at about only 80 per cent of its capacity at the output figures given. The basis of comparison therefore, for the grinding, pulverizing and burning machinery, which is operating on cement rock in the Lehigh Valley, is not a fair one.

The stone is loaded with a steam shovel, crushed in a gyratory crusher, further reduced in a Williams' mill, and dried in rotary driers. The shale or clay is loaded with a steam shovel, run through a dry pan mill, dried, and meets the stone at the weigh bin where the mixture is proportioned. It then passes through a rotary mixer to ball mills and is finished in tubemills, burned in rotary kilns, and the cement clinker then crushed in ball mills and finished in tubemills.

Electrically, the conditions are practically the same as those described for plant No. 4.

The power plant consists of six up-draft producers in place of the usual steam boilers, the generating gas operating three 34-in. by 48-in. horizontal tandem gas engines driving three 750-k.w. three-phase, 25-cycle, 440-volt alternators.

It may appear that this paper emphasizes the relative efficiencies of different raw materials, types of grinding machinery and engineering arrangements. The presence of these as variables is admitted, especially when the plants cited are in different localities, but fortunately we have exactly the same types of machinery and in most cases the same size and make in the comparisons given, if not throughout the entire plant, at least throughout entire departments which represent the several stages in the manufacture of cement from the raw materials.

In explanation of the lettering of the different departments in Table 1 the quarry is considered as A; preliminary crushing, secondary breaking down and storing of the raw materials as B¹; the drying, grinding and pulverizing of the raw material as B²; subdivisions, B¹ and B² as the raw end B; burning the raw material to cement clinker and cooling it as department C; crushing, grinding and pulverizing the cement clinker as department D,—D¹ being the preliminary crushing and grinding, and D² the finishing or pulverizing.

Comparing the figures in Tables 1 and 2 in connection with the brief description of the plants, it is seen that a direct-driven plant shows a power economy greater than an electrically driven plant.

Plants Nos. 2, 3 and 5 are comparable in departments B¹ and B² with but small opportunity of error in that the size, type and make of the granulating and pulverizing machinery is identical. It will be noted that a barrel of finished raw material at the kiln bins department B, consumes as follows:

I. H. P.		
	Total	Per Bbl.
Plant No. 1.....	387	0.403
Plant No. 2.....	416	0.341
Plant No. 3.....	602	0.276
Plant No. 4.....	736	0.626
Plant No. 5.....	860	0.478

Plants Nos. 3 and 4 have twice the number of kilns, feeders for both pulverized coal and raw material, low-pressure air systems, elevators and auxiliaries that plant No. 2 has. Plant No. 5 has the same number of kilns, etc. as plant No. 2, but the kilns have twice the area and length and the auxiliaries are twice as large. We have as a comparison, however:

I. H. P.		
	Total	Per Bbl.
Plant No. 1.....	38	0.0396
Plant No. 2.....	37	0.0303
Plant No. 3.....	159	0.073
Plant No. 4.....	86	0.0732
Plant No. 5.....	170	0.0945

In the clinker-grinding and finishing departments D we find a greater difference in the machinery used, that is; when comparing plants Nos. 2, 3 and 5, but the department D of plant No. 4 is comparable with that of plants No. 2 and No. 3 with reference to the grinding machinery used, and we have:

I. H. P.		
	Total	Per Bbl.
Plant No. 1.....	300	0.312
Plant No. 2.....	476	0.390
Plant No. 3.....	750	0.341
Plant No. 4.....	531	0.452
Plant No. 5.....	962	0.534

From the above it will be noted that in practically every instance the direct-driven plant is more economical in power consumption, than the electrically-driven plant.

In considering this subject it has appeared to me that the pounds of coal used per indicated horsepower do not show the true condition, so the equivalents in British thermal units are given in Table 2.

From Table 2 it appears that the power plant No. 5 using the most direct method of transmitting the

thermal power of the fuel to the prime mover, i.e., by means of the gas generated by partial combustion of the fuel in a producer, shows the lowest B.t.u. consumption and highest thermal efficiency, but on account of the losses inherent in the balance of the power transmission system, uses more i.h.p. per bbl. of cement produced than do plants Nos. 1, 2, 3 and 4. The same is true of plant No. 4 as compared with plants Nos. 1, 2 and 3, from which it appears to me that in addition to all of the losses inherent in a direct-driven plant, the electrically-driven plant has, in addition, those decreased efficiencies representing losses in the conversion of mechanical power to electrical power and back from electrical power to mechanical.

We have, for instance, in plants Nos. 1, 2 and 3 the fuel fired under boilers, generating steam which, in turn, is used in the engines giving motion and power to the lineshaft. Through the aid of a belt this power is then transmitted to the several machines by means of belts, gears, chains, ropes, etc. In this arrangement we have the losses shown in column 1 below.

In plant No. 4 the fuel is fired under boilers, and steam is used in the turbine to generate electrical current in the alternators, the current produces motion and power in the motors which is transmitted to the machines, through a belt to a counter-shaft, and thence by belt, gearing, chain or rope to the machine, and the losses are as shown in column 2 below.

In plant No. 5 the fuel is fired into a producer which supplies gas to an engine operating an alternator generating current from which point the cycle is the same as in plant No. 4, and the losses are as shown in column 3 below.

Plant Numbers		
1, 2 and 3	4.	5.
Furnace	Furnace	Producer
Boiler	Boiler	Engine (gas)
Engine	Engine (turbine)	Generator
Belting		Line
Lineshaft	Generator	Motor
Lineshaft	Line (circuits)	Belt
Belting	Motor	Lineshaft
	Belt	Belt
	Lineshaft	
	Belt	

The above are all comparable on a monetary basis, but time and space will not permit going into this. It is appreciated that given a water-power proposition, that the proper installation is a hydro-electric one, but it is believed that the most economical cement plants of the future, that is, from a power consumption standpoint, will be developed along the lines of a producer as the first step in the cycle of power conversion and transmission; then an internal-combustion engine operating the main departments direct connected to the lineshaft, and the waste heat from these engines utilized in an exhaust or low-pressure steam turbine operating direct-current generators, which current so generated will be used for lighting and the operation of isolated and remote machines.

The Western Concrete Pole & Post Co. has been incorporated at Ogden, Utah, to manufacture posts, poles, sewer pipe and other articles of concrete. Capital stock, \$50,000. Incorporators: George Maitland, W. M. Jefferis, S. F. Halverson, A. L. Corey, Sidney Bamberger and J. B. Bean.

Syracuse capital to the amount of \$300,000 has been invested by the Thomas Millen Co., in the erection and equipment of one of the largest and most modern independent Portland cement plants in the country. Work was started one year ago in June and it is stated the plant will be ready to produce from 750 to 1,000 barrels per day in a few weeks.

TABLE 1 DATA UPON THE POWER DISTRIBUTION IN FIVE CEMENT PLANTS

Plant No. 1	1	2	3	4	5
Nominal Capacity, Bbl.	1000	1200	2000	2000	2500
Actual Capacity, Bbl.	960	1220	2180	1176	1800
Indicated Horse Power					
Gross Developed	305	1020	1694	1489	2430
Cement per Bbl.	0 839	0 835	0 777	1 26	1 35
Hours, per Bbl.	20 15	20 04	18.65	30.75	32 4
Coal Cost, per Ton	\$2 76	\$2 12	\$2 45	\$1.25	\$1.50
Cost Coal, Cents per H p-hr	0 00653	0 00325	.00411	0.00119	0.0019
Lb. per H p	5 32	3 44	3 8	6.7	2 87
Proportion to Departments					
B ₁ H.p.				189	136
%				12 7	5.6
B ₂ H.p.				547	724
%				36 8	29.8
B ₃ H.p.	387	416	602	736	860
%	48	40 75	35.5	49.5	35.4
C ₁ H.p.	38	37	159	86	170
%	4 5	3.5	9.5	5.8	7.0
D ₁ H.p.					
%					
D ₂ H.p.					
%					
D ₃ H.p.	300	476	750	531	962
%	38	46 75	44.5	35.7	39.6
Coal, Gr	80	90	183	132	436
%	9 5	9.0	10.75	8.86	18

TABLE 2 HEAT UNITS PER I. H. P. PER BARREL CEMENT

Plant No	Coal, Lb per I.H.p.-Hr	B t. u per I.H.p.-Hr.	Power Coal, Lb per Bbl. Cement	B. t. u per Bbl. Cement
1	5 32	71,022	107 19	1,430,960
2	3.44	40,560	68.94	792,782
3	3.80	45,600	70.87	850,440
4	6 7	82,745	200.03	2,470,308
5	2.87	21,094	92.99	683,462

Jones & Heltzel Co., Streator, Ill., is manufacturing a new system of forms for sidewalks, curbs and gutters. This is known as the Heltzel system, and a notable feature is that no keys, wedges or clamps are used in connecting the forms together. The manufacturer claims that forms can be set up and dismantled without the aid of a hammer. The side rails are adjustable and interchangeable. These forms are provided with a division plate stiffener bar to hold the plates in line while concrete is being stamped. This insures straight expansion points. A self-retaining straight edge is also used in connection with this system. Full particulars can be secured by addressing the manufacturer.

The Acme Tiling & Concrete Co. has been organized at Paragould, Ark., with \$25,000 capital stock, to manufacture tiling and concrete blocks. A. Bertic is president; H. S. Trice, treasurer; D. D. Hodges is secretary, and D. G. Woody is vice-president and manager.

\$1,000,000 CONCERN TO QUIT.

The Hecla Company of Detroit, capital \$1,000,000, has filed a notice of dissolution. The company for years operated a cement plant at Bay City, also the Hecla Belt Line Railroad. Trade conditions that at present operate against the cement business and discriminatory freight rates on cement in the middle section of the country are the assigned causes for going out of business.

Standard Tests of Drain Tile and Sewer Pipe.

At the recent convention of the Iowa Cement Users' Association, Prof. A. Marston and A. O. Anderson presented an exhaustive paper on the subject of standard tests of sewer pipe and drain tile, presenting a set of specifications as used at the experiment station at Ames, with a view to their general adoption by the Cement Users' Association, as well as other interested state organizations.

The paper takes up first the requirements for standard testing methods, which are five in number, as follows:

First—The most cardinal requirement is that the test should plainly show the real quality of the material or product which is being tested. By quality is meant the ability of the material or product to resist the destructive agencies which act upon it during its actual use for the purpose for which it was intended.

tile factory should be able to test its products, to ascertain whether they are going to meet the conditions of use or not. Every county and drainage engineer should be able to test the material delivered on the work to ascertain whether it complies with the requirements of the specifications or not.

Fifth—The standard test should be easy and inexpensive to make. This includes the requirement of rapidity as well as those which have already been discussed just above.

The cardinal qualities of drain tile and sewer pipe are two in number, says the report:

First—The quality of the material, of which the pipe is made, and

Second—The strength of the pipe.

The quality of the material is a cardinal quality, because the pipe will disintegrate and go to pieces unless



Concrete Dormitory for Pomona College, Pomona, Cal. White Cement used for Exterior Finish. Richards-Neustadt Construction Co., Contractors, Los Angeles.
Hunt & Gray, Architects, Los Angeles

It would be of no use, for example, to test the resistance of cement tile to sulphuric acid unless it is likely to be subjected to the action of sulphuric acid during its use for drain tile.

Second—It is desirable that the standard test should be a direct test, as distinguished from an indirect test. By a direct test is meant one which directly subjects the material or product to the action of destructive agencies closely similar to the ones which will act upon it in its actual use. By an indirect test is meant a test of the material or product under the action of agencies which are not closely similar to the ones which come upon the material in its actual use, but which are such as to develop a quality of the material or product from which its behavior in actual use may be indirectly inferred.

Third—The standard test should be accurate. In other words, the method should be such that the test can be made by different experimenters and in different laboratories with the assurance of obtaining the same result on the same quality of material.

Fourth—The standard test should be simple. This is especially necessary for a satisfactory standard test for sewer pipe and drain tile. To make the standard test of the greatest value, every town constructing a sewer system should be able to test the sewer pipe without great expense. Every sewer pipe and drain

tile of which it is made is of such durable quality as to resist all disintegrating agencies. A cement tile must be made of hard, dense, uniform and comparatively impervious concrete in order to resist the action of destructive agencies, and to prevent their ready penetration into its pores. In the same way, soft and under-burned sewer pipe or clay drain tile are unsatisfactory, since such pipe cannot resist the action of freezing and thawing, and may disintegrate from other agencies. Also, a laminated structure in clay drain tile or sewer pipe prevents resistance to frost and causes failure. High bearing strength of the pipe, as a whole, is not a satisfactory indication of the quality of the material from which the pipe is made, for high strength may be secured by using thick walls. Drain tile or sewer pipe with thick walls may be strong enough, and yet may be porous and disintegrate.

Two simple tests may be made to determine the quality of the material of which drain tile or sewer pipe are made, namely, the absorption test and the determination of the modulus of rupture. The absorption test is of great importance for cement and clay tile. In the case of cement tile, the agencies tending to destroy the concrete cannot act with much rapidity unless they obtain access to the interior of the concrete walls. In the case of clay tile, the action of

freezing would not be of much importance unless water could obtain access to the interior of the walls. Hence, the absorption test has a greater importance in testing drain tile and sewer pipe than in the case of most other materials of construction. For this reason, and because it is simple and easy to make, we advocate it as one of the standard tests for drain tile and sewer pipe.

By the modulus of rupture is meant the tensile breaking strength of the material of the pipe wall, as calculated from the results of the bearing strength test. The determination of the modulus of rupture requires no independent test of the material, and it will probably give an important indication of the quality of the material. The modulus of rupture for drain tile and sewer pipe, calculated as above, exactly corresponds to the modulus of rupture of paving brick calculated from the results of transverse tests.

Hence, we recommend three standard test requirements for drain tile and sewer pipe, namely, the per cent of absorption, the modulus of rupture, and the bearing strength of the pipe. These three test requirements involve two standard tests, namely, the absorption test and the bearing strength test.

The making of absorption tests has been standardized for paving brick, but not for other materials. The standard method for paving brick can be used as a basis from which to start in determining the standard method for drain tile and sewer pipe. Studying these standard requirements, there seems to be no reason for varying the process in any material point except in the case of the time of immersion. In the case of paving brick, the standard time of immersion is forty-eight hours. Our tests of drain tile and sewer pipe, as well as those of brick, indicate to us that it will be safe to reduce the standard time of immersion to twenty-four hours for drain tile and sewer pipe, and, as this cuts the time required in half, we recommend this change. Our full standard specifications will be found given in detail below.

It is in the method of testing bearing strength that we find the most room for discussion. While tests of bearing strength have not been very extensively made, yet they have been in progress, to some extent, for many years, and, as no standard method has been adopted, several methods are in use.

The Engineering Experiment Station of the Iowa State College has been making tests of drain tile and sewer pipe for several years. When this work first began it became necessary to devise a standard method for making the tests. The question first came up in connection with the failure of cement drain tile of large size in a drainage ditch. The station staff made an investigation in the field, and, after careful study, devised a standard method which has been used ever since. This method has stood well the test of several years of use, and further thought and study, as well as experience with it, have thoroughly convinced the staff of the engineering experiment station that it is by far the best method to use in testing the bearing strength of drain tile and sewer pipe. It is, therefore, proposed as standard.

The proposed standard method is as follows:

On studying the failures of drain tile and sewer pipe under actual use, it was found that in actual construction work the pipe are always liable to be left in the ditch without firm support of their sides, from solidly tamped earth. Also, the bearing of the lower half of the pipe against the foundation is almost certain to be very incomplete. The earth toward the side of the ditch settles away from the pipe. Of course the top bearing extends over the full width of the pipe.

After careful consideration, it was concluded that the effect of the field conditions could be nearest duplicated in a standard test by imbedding the pipe in sand at both top and bottom for one-fourth the circumference, measured along the line of the middle thickness of the wall.

Extended experience since the method was first adapted has not changed the conclusion that the results obtained in this way would come nearer to indicating the strength actually developed in a ditch, under ordinary conditions, than any other proposed method. In the Sac County failure, for example, three of the drain tile from the ditch were sent to the Experiment Station at Ames, and tested there. They were found to give an average bearing strength of 2,150 pounds per linear foot, which would correspond approximately to a depth of earth filling in the ditch of six feet over the top of the tile. The actual depth of filling in the ditch varied from four and one-half to ten and one-half feet, and it seems altogether probable that the pipe failed at about the depth of filling indicated by the tests of the Engineering Experiment Station.

The proposed standard test has, therefore, the merit of being a direct test. That is, it indicates approximately the strength of the pipe as used in the ditch. Of course, in this connection, it must be remembered that the treatment to which the pipe are subjected in the ditch varies, and that it would be possible so to lay them that they would not carry so much load as indicated in the standard test, or so they would carry more. We believe, however, that the proposed standard test gives bearing strengths which are safe to use in determining whether a sewer pipe will ditch, under ordinary conditions.

Further, the proposed standard test avoids all splitting stresses due to the character of the material bearing against the pipe. Such horizontal stresses as are introduced are compressive, and can be calculated beforehand.

Further, sand is a material which can be obtained in any community for the test, and is cheaper than any material which would be likely to be substituted for it.

Further, by marking the pipes in quarters before testing, it is possible to insure accurate bedding in the sand, both above and below, and the method is therefore accurate.

The method permits the testing of pipe with bells as readily as those without, since the bells, as well as the straight pipe, can be imbedded in the sand bearing. We have made numerous tests of sewer pipe with bells, and find no difficulty in the work.

The method is one which can be adopted for test in the field, without any testing machine, with absolutely accurate results. It is simple and can be carried out by any competent engineer, or by any competent superintendent of a factory. It is a method which is fair both to cement pipe and to clay pipe. It is a method which does not require translation to be understood by people who are not engineers or manufacturers, which is not the case where tests are made with concentrated loads, since these do not give the actual strength of the pipe as used in the ditch.

In order that any standard test of drain tile and sewer pipe may prove successful, it must be possible to make it extensively and at low cost. Hence, it is essential that the test be such as can be made on an inexpensive machine. It should be possible for any city to test its sewer pipe, for any county to test its county drain tile, for any superintendent or owner of a factory to test his product.

The proposed standard test is almost ideal in this respect:

1. It is possible to make the test without any testing machine whatever. The forms for the top and bottom beds can be made of wood by anyone, and the loading can be applied by piling on brick, or sacks of cement, or any convenient material.

2. Up to the maximum capacity of a pair of ordinary platform scales, the Ames Junior testing machine can be used. It could be made at an expense of \$15.00, plus the cost of a 2,000 pound platform scales, or, say, total of \$50.00. The scales could be used for other purposes around a plant as well as for testing, so that the cost to be charged to the machine would be very small indeed in the case of a current tile manufacturing plant. It is possible to load the ordinary platform scale considerably higher than the limit for which it was designed, without serious danger of injury, so that a 2,000 pound scale could be made to answer for a test of 4,000 or even 5,000 pounds for a few tests.

Mr. C. W. Boynton, of the Universal Cement Company, has devised a similar machine which is available for the same purpose, and could probably be made at about \$75.00, including scales. We do not, in any case, advise the use of the three-point bearing which he has adopted with his machine, but there is no reason why his machine could not also be used in connection with the method of bedding recommended in the standard specifications.

However, our experience in cement tile testing shows that the loads not infrequently run up to 5,000 to 7,000 pounds per specimen. Hence, a more powerful machine is needed for general work than either the Ames Junior testing machine, or the Universal machine.

We have devised and constructed the Ames Standard testing machine, and which cost us \$100 to build, including \$65 for material and \$35 for labor. The Ames Standard testing machine has a capacity of 16,000 pounds with a 1,600 pound platform scales. The machine is capable of testing any size of tile up to 4 feet in diameter.

We will furnish blue print plans of either the Ames Standard testing machine, or the Ames Junior testing machine, to anyone desiring them, and recommend any county, city or cement tile factory to send a mechanic to Ames to look over the machines and secure these blue print plans to enable their own construction of machines.

We give beneath, definite specifications for standard tests which we ask to have adopted:

1. Specimens.—The specimens shall be each approximately two inches square, and shall extend the full thickness of the pipe wall, with the outer skins unbroken.

2. Number of Test Specimens.—Five individual tests shall constitute a standard test, the average of the five, and the result for each specimen, being given in the report of the test.

3. Drying Specimens.—Each specimen shall be dried in an oven or by other application of artificial heat, until they cease to lose further appreciable amounts of moisture when repeatedly weighed.

4. Brushing Specimens.—All surfaces of the specimens shall be brushed with a stiff brush before weighing the first time.

5. Weighing.—The specimens shall be weighed immediately before immersion, on a balance or scales capable of accurately indicating the weight within one-tenth of one per cent.

6. Water for Standard Test.—The water employed

in the standard absorption test shall be pure soft water, at the air temperature of a room which is artificially heated in cold seasons of the year.

7. Immersion of Specimens.—The specimens shall be completely immersed in water for a period of twenty-four hours.

8. Re-Weighing.—Immediately upon being removed from the water, the specimens shall be dried by pressing against them a soft cloth or a piece of blotting paper. There shall be no rubbing or brushing of the specimen. The re-weighing shall be done with a balance or scales capable of accurately indicating the weight within one-tenth of one per cent.

9. Calculation of Result.—The result of each absorption test shall be calculated by taking the difference between the initial dry weight and the final weight, and dividing the remainder by the initial dry weight.

Specifications for Standard Tests of Bearing Strength.

1. Specimens.—The specimens shall be unbroken, full sized samples of the pipe to be tested. They shall be carefully selected so as to represent fairly the quality of the pipe.

2. Number of Specimens.—Five individual tests shall constitute a standard test, the average of the five and the result for each specimen being given in the report of the test.

3. Drying.—The specimens shall be dried by keeping them in a warm, dry room for a period of at least two days prior to the test.

4. Weighing.—Each dried specimen shall be weighed on a pair of reliable platform scales just prior to the test.

5. Bedding of Specimen for Test.—Each specimen shall be accurately marked, with pencil or crayon lines, in quarters, prior to the test. Specimens shall be carefully bedded above and below in sand for the one-fourth circumference of the pipe, measured on the middle line of the tile wall. The depth of bedding above and below the tile at the thinnest point shall be equal to one-fourth the diameter of the pipe, measured between the middle lines of the tile walls.

6. Top Bearing.—The top bearing frame shall not be allowed to come in contact with the tile or with the test load. The upper surface of the sand in the top bearing shall be made level and shall be carefully covered with heavy cross plank or timbers capable of uniformly distributing the test load without any appreciable bending. On top of these cross plank or timbers shall be placed a heavy longitudinal timber capable of distributing the load to the cross timbers without any appreciable bending. The test load shall be applied at the exact center of this top timber in such a way, either by the use of a spherical bearing, or by the use of two rollers or rods at right angles, as to leave the timber free to move in both directions. In case the test is made without the use of a machine, and by piling on weight, the weight may be piled directly on a platform resting on the cross timbers, provided, however, that the weight does not touch the top frame holding the sand, and provided, further, that the weight is piled in such a way as to insure uniform distribution of the load over the top surface of the sand.

7. Frames for Top and Bottom Bearings.—The frames for the top and bottom bearing shall be composed of timbers so heavy as to avoid any appreciable bending by the side pressure of the sand. The frames shall be dressed on their interior surfaces. No frames shall come in contact with the tile during the test. A strip of soft cloth may be attached to the in-

side of the upper frame on each side along the lower edge to prevent the escape of sand between the frame and the tile.

8. Sand in Bearings.—The sand used for bedding the tile at top and bottom, shall be material which has passed a No. 8 screen and has been retained on a No. 16 screen. It shall be dried by keeping it spread out thin in a warm, dry room.

9. Application of Load.—The test load shall be applied gradually and without shock or disturbance of the tile. The application of the load shall be carried on continuously, and the tile shall not be allowed to stand any considerable length of time under a load smaller than the breaking load.

10. Calculation of the Bearing Load.—The total breaking load shall be taken as equal to the total top load, including the weight of top frame, sand for top bearing, top bearing timbers, etc., plus five-eighths of the weight of the pipe. This total load shall be divided by the length of the pipe in feet so as to give the bearing strength per linear foot of pipe.

The modulus of rupture for drain tile and sewer pipe shall be computed from the results of the standard test for bearing strength, according to the following rule:

Divide the bearing strength per linear foot by 12, multiply the quotient by the radius of the middle line of the tile wall expressed in inches, and divide this product by the square of the minimum thickness of the tile wall at top or bottom, also expressed in inches. This quotient will be the modulus of rupture of the pipe expressed in pounds per square inch.

THE ACTION OF MINE WATER ON CONCRETE.

The action of mine water on concrete has been under observation for some years by R. D. Richardson, concrete engineer for the Coal Mining Department of the Delaware, Lackawanna & Western Railroad, and as a result he has concluded that dense concrete made with proper materials will not be affected by mine water of the quality found around Scranton, Pa. This water in the only analysis made showed $\frac{1}{4}$ per cent of sulphuric acid. It should be understood, however, that this conclusion is based on observations of concrete not subjected to abrasion, and might not apply, for instance, to the concrete in the inclined bottoms of coal pockets. The water analyzed comes in contact with the reinforced concrete dam described in the Engineering Record, March 27, 1909, and after three years of service the acid has had no deteriorating effects. Mr. Richardson has immersed small blocks of dense concrete, having a piece of steel embedded in them, in mine water for fifteen months. When broken the metal was as bright as it was the day the blocks were made. Several instances have been noted of the entire destruction of concrete by mine water, but Mr. Richardson states that this was due to the porosity of the concrete and to the poor materials, slate and "bony," a flinty slatey rock, which were used. Slate and "bony" deteriorate rapidly under the action of mine water. The company has a number of concrete coal pockets which have not been emptied for a long time, and, consequently, it is not known how the abrasion combined with acid water is affecting the concrete. The action feared is the formation of calcium sulphate, which is readily abraded, thus offering a fresh surface to the attacking waters. The concrete appears, however, to be in good condition—Engineering Record.

VALUABLE CEMENT LITERATURE.

The literature of an art not only records its development, but fixes the advancement made so that, even though it should for a time fall into disuse, it could easily be revived and placed on a practical basis. It does much more than that since it educates thousands who otherwise would have to learn every step in the slow and costly school of experiment. The literature of Portland cement and the great concrete industry depending upon it, has developed remarkably during recent years, and is now fully abreast of the latest discoveries and improvements.

The contributions to this literature made by the Atlas Portland Cement Company, 30 Broad street, New York, are second in value to those of no other like corporation in the country. We have received copies of four books issued by this company that are of distinct value to the industry and a decided advantage to those employing or wishing to employ concrete. "Concrete in Railroad Construction," is a work of 228 pages, scientifically written and accompanied with a large line of illustrations that add greatly to the clearness and force of the text. It is a treatise for railroad contractors and engineers and covers the entire field, leaving nothing to be desired by one who seeks full information on the subject. "Concrete in Highway Construction," is another handsomely illustrated book. This is described as "A Text-Book for Highway Engineers and Supervisors," a designation which it amply justifies. A third book, and one of peculiar value in widening the field of concrete through popularizing it is entitled "Concrete Construction About the Home and on the Farm." It is written in a popular and practical way and will enable any one of ordinary intelligence and some idea of the use of tools to use concrete in making a wide range of improvements at a small expense as compared with other forms of construction. "Concrete Garages" is the caption of the fourth book, presenting illustrated descriptions of numerous attractive garages, with detailed directions of how to construct them. These books are fairly entitled to a place in the literature of concrete, and are certain to greatly aid in its development.

Atlas Portland Cement enjoys a splendid reputation which has become world wide; this may chiefly be attributed to the great care exercised in the process of manufacture and to the excellent raw material at their disposal. All the buildings illustrated in this issue were reproduced from "Concrete Country Houses," published by the Atlas Portland Cement Company.

REINFORCED CONCRETE.

"Reinforced Concrete," by John P. Brooks, director of the Clarkson School of Technology, has just been published.

It is a modern treatment of mechanics and design, with valuable material for builders and users of cement and concrete.

It does not attempt to cover the constantly changing details of reinforced concrete construction, but devotes itself to analysis and design. To make these more readily comprehensible several designs of reinforced concrete structure are worked out in detail with particular reference to the proper sequence of computation. The principles of economy in design are set forth, and the diagrams in use lead to the proper selection of steel and concrete dimensions.

This book simplifies the methods of analysis and design in reinforced concrete. It is a concise treatise that is admirably adapted to the needs of engineers and students. Price, \$2.00.

FIVE-INCH CONCRETE PAVEMENT LAID IN ONE COURSE.

A considerable amount of concrete pavement is to be constructed this year for the city of Sioux City, Ia., under specifications which are somewhat of a departure from those heretofore used for this type of pavement. The greatest change is that the Sioux City pavement is to be laid practically in one course. Another departure is the use of but five inches of concrete instead of seven inches. For securing a smooth surface without the use of a top coat, a special bar should be used. This bar tamper has been perfected by Mr. Keyes C. Gaynor, City Engineer of Sioux City. It is made of one-half inch square steel bars placed one-quarter inch apart and set so as to strike diamond wise. This, it has been found, drives down in tamping, everything larger than one-quarter inch and everything smaller comes up between the bars. The result is the securing of practically four and one-half inches of coarser materials and one-half inch of top coat, all made and laid at one operation. Regarding this tamper Mr. Gaynor informs us that there are several minor changes that could be made in the tamper to advantage, such as making the tamper a little lighter and not letting the outside edge project beyond the face of the tamper. The main features of the Sioux City specifications as prepared by Mr. Gaynor are as follows:

Fine aggregates shall consist of sand, crushed stone or gravel screenings, graded from fine to coarse, passing when dry a screen having one-quarter inch diameter holes, shall be preferably of silicious materials, clean, coarse, free from loam, vegetable or other deleterious matter, and not more than 3 per cent shall pass a sieve having 100 meshes per linear inch.

Coarse aggregates shall consist of inert material, graded in size, such as crushed jasper, granite or gravel, which is retained on a screen having one-quarter inch diameter holes, shall be clean, hard, durable and free from all deleterious matter. Aggregates containing soft, flat or elongated particles shall be excluded. The maximum size of the coarse aggregate shall not exceed that which will pass a one and one-half inch ring.

Expansion joints one-half inch wide shall be placed across the street every fifty feet between the curbs or edge of the gutters. All boards for expansion joints shall be made in the form of a template, cut to the desired shape of the street according to plans for detail of each street, and shall not project above the finished pavement. Contraction joints shall be cut entirely through the pavement on the streets as shown on the plan for detail of each street.

The expansion joint filler shall be a suitable elastic, waterproof compound that will not become soft and run out in hot weather or hard and brittle and chip out in cold weather.

The concrete for the base shall be so proportioned that the cement shall overfill the voids in the fine aggregate by at least 5 per cent, and the mortar shall overfill the voids in the coarse aggregate by at least 10 per cent. The proportions shall not exceed 1 part cement to seven and one-half parts fine and coarse aggregates.

When the voids are not determined the concrete shall have the proportions of one part cement, three parts fine aggregate and four and one-half parts coarse aggregate.

The ingredients of the concrete shall be thoroughly mixed dry, sufficient water added to obtain the desired consistency, and the mixing continued until the ma-

terials are uniformly distributed and the mass is uniform in color and homogeneous.

When the conditions will permit, a machine mixer of a type which insures the uniform proportioning of the materials throughout the mass shall be used.

When it is necessary to mix by hand, the mixing shall be on a water tight platform and the materials shall be turned until they are homogeneous in appearance and color.

The materials shall be mixed wet enough to produce a concrete of the consistency that will flush readily under light tamping, but which can be handled without causing a separation of the coarse aggregate from the mortar and which will not creep towards the curb or sag out of place when deposited and lightly tamped.

Retempering, that is, remixing with additional water, mortar or concrete that has partly hardened, will not be permitted.

The concrete shall be deposited in strips extending the full width of the area paved. After the addition of water the mixture shall be handled rapidly to the place of final deposit. Under no circumstances shall concrete be used that has partly hardened.

Concrete shall not be mixed or deposited when the temperature is below freezing, and shall be protected against frost until thoroughly hardened. Concrete shall not be mixed or deposited when the temperature is too high and all work shall be covered as directed by the City Engineer.

Workmen shall not be permitted to walk on freshly laid concrete, and where sand and dust collect on the base it shall be removed carefully before the wearing surface is applied. A practical skilled workman shall do the spreading of the concrete and the finishing of the surface.

After the concrete is deposited it shall be tamped as directed by the City Engineer and his inspector on the job, after the tamping, enough dry mixture, mixed one part cement and one part fine aggregate is to be spread over the surface in sufficient quantity to take up the surplus moisture. The surface must be then floated to true grade. If the concrete has not been graded to get a surface sufficiently true it shall be brought to a true surface by a mixture of one part cement and one and one-half parts coarse sand before the dry mixture is applied.

The wearing surface shall be spread on the base immediately after mixing, and in no case shall more than 50 minutes elapse between the time that the concrete for the base is mixed and the time the wearing surface is floated.

The wearing surface shall be finished with a wood float, and before it has completely hardened it shall be roughened by brushing with a stiff vegetable fibre brush or broom.

When the surface is to be corrugated the grooves shall be approximately three-eighths inch deep and one-quarter inch wide with the edges neatly rounded to prevent chipping or spalling. The grooves shall be perpendicular to the axis of the street and be approximately six inches center to center. After grooving, the surface shall be roughened by brushing as above specified.

The edges of all expansion and contraction joints shall be rounded to a radius of about one-half inch.

When complete, the pavement shall be well sprinkled with water for a period of at least three days and shall not be thrown open to traffic until the Engineer so directs and shall be covered with one inch of yellow clay, if so directed by the City Engineer.

In laying the pavement work shall be started at the bottom of the hill and carried up.

The Natural Increase In the Ratio of Burden to Labor In Modern Manufacturing Processes

By James B. Stanwood

In all manufacturing processes in the determination of the cost of the finished article it is usually to divide it into three elements—the cost of the material used, the cost of the labor that can be charged to the conversion of this material into the finished product, and the amount of the burden, or overhead expense. This burden includes the cost of all other expenditures of labor and material necessary for carrying on the processes of production, which are general in their character and which can not be charged directly to any portion of the actual labor or material. In this connection the cost of selling the product should not be neglected, but should be considered a part of the burden. The ratio then of the burden to the direct labor or burden-labor ratio may be expressed by a fraction B/L in which B represents the total cost of the burden of a department or factory for a unit period of time, and L the total direct labor cost of the same, for the same factory or department, for the same unit of time.

As a result of the constant improvement in machinery and processes, or, to use a popular phrase, because of the increase in "labor-saving devices," it can be stated as a law that: The ratio of burden to labor naturally tends to increase from year to year or period to period as industry progresses.

This can be shown by an illustration: Let the material, labor and burden in a given process be equally divided so that each has a unit value of 2; then the total cost is 2 plus 2 plus 2 equals 6; the burden-labor ratio being 2-2 equal 1. If, now, by an improved machine, or by an improved process the labor is cut in half, then the total cost becomes 2 plus 1 plus 2 equals 5, and the burden-labor ratio will be 2-1 equals 2. This is on the assumption that no other change has been made than that of cutting the labor in two. Let us consider a different set of values in which the material is assumed to be 2, labor 12 and burden 6. The total cost then becomes 2 plus 12 plus 6 equals 20, and the burden labor-ratio is 6-12 equals $\frac{1}{2}$. Suppose that an improved process or machine now reduces the labor from 12 to 3, a rather uncommon experience; now the total cost becomes 2 plus 3 plus 6 equals 11, and the burden-labor ratio is 6-3 equals 2. The saving in total cost is 45 per cent, but the burden-labor ratio is increased fourfold.

In many cases in practice the saving in labor as outlined in these examples is brought about by the introduction of some new device or machine which is sold generally to the trade so that it is open to all manufacturers to secure the benefit of this improvement, but it also usually happens that the competition among manufacturers gives most of this benefit to the consumer, and after a short period all the manufacturers are practically on the same basis, using the same grade of materials, the same type of tools and employing labor at about the same cost.

If this law of the natural increase of burden-labor ratio is not recognized, it follows that manufacturers who base their cost estimate on previously ascertained burden-labor ratios find themselves in the position of selling their goods at a low margin of profit, or no profit, or even at a loss.

The two examples here given assume that the total

burden itself does not in any way increase or decrease absolutely; on the other hand, in many instances where improved machines or appliances are employed the total burden itself actually does increase. More elaborate machinery calls for greater care for up-keep and for a greater depreciation. It frequently follows that although the net cost of the product is greatly reduced by a saving in labor, yet this entire saving in labor is not realized on account of the actual increase in burden.

A prominent manufacturer recently stated to the writer that the use of "high-speed" steel greatly increased his burden-labor ratio over the use of the older steels. This, of course, is due to the reduction in labor cost which the "high-speed" steel affected, but in addition the increased cost of this steel and the increased cost in the up-keep and the depreciation of machines required to use this steel also increase the actual burden; the net manufacturing cost; however, has been greatly reduced by the use of these improved cutting metals.

The reduction in the labor cost of an article as shown above cheapens it to the manufacturer and, ultimately with free competition among the manufacturers, cheapens it to the consumer.

The usual advantage claimed for labor-saving machines to the manufacturer lies in the fact that they increase the capacity of his plant. If, as in the last rather extreme example, the labor cost is reduced one-fourth of what it originally was, it means that one man or one machine will produce four times more than before the improvement was adopted. The result of this is a large increase in plant capacity, with the attending necessity of finding a correspondingly large market for the output. When the reduced cost of production gives one manufacturer an advantage over another he secures his market by taking the trade from the other, who may be less favorably equipped. When, on the other hand, all manufacturers in the same line install the same machinery at about the same time and, by competition, the price is reduced, then the only increase in market can come about by reason of the reduced cost to the consumer. In some cases a greater demand due to the decrease in the cost of goods tremendously increases the volume of business; in others, where a decrease in cost does not easily produce an increase in demand, the burden is increased in the effort to make a market.

Man has been called the "tool-using animal." This is not entirely true. A spider spins a web, which is his tool for trapping his food; the bee makes a cell in which to store its honey, and the beaver builds for himself a dam and waterproof hut. Today the spider spins his web after the same pattern he used thousands of years ago; the bee has not altered the construction of the honey comb; the beaver uses the same devices for cutting down trees, digging up earth and stones and plastering his masonry—the burden-labor ratio has remained the same.

But man, who in the beginning had but few implements, and these of the crudest form, has, during the process of his marvelous development, made his tools more and more efficient and elaborate, and thereby has greatly increased the burden-labor ratio.

A striking example of this extensive and elaborate use of tools is found in the appliances used in the numerous processes of the entire plant which the United States Steel Corporation has in operation for digging the iron ore from the ground in Minnesota, conveying it to Gary, Ind., and making it into manufactured steel products, such as rails, structural steel, etc. In this continued process from Mother Earth to the finished product very little direct labor is placed on the material in the entire course of its conversion. Everything is done by machine—from the digging of the ore, its transportation by steam through the lakes, the unloading and the feeding of the ore to the furnace, the conversion of the melted metal into steel, the formation of a billet into a finished product. In this case the actual labor falls on those who attend the machines. This includes, of course, the sailors and crews on the lakes, operators on the railroad in Minnesota, as well as the men at the mines and in the steel plant at Gary.

This extensive operation possesses a tremendous burden in relation to the direct labor expended, and yet, as is well known, the entire process is one embodying the highest economy of production.

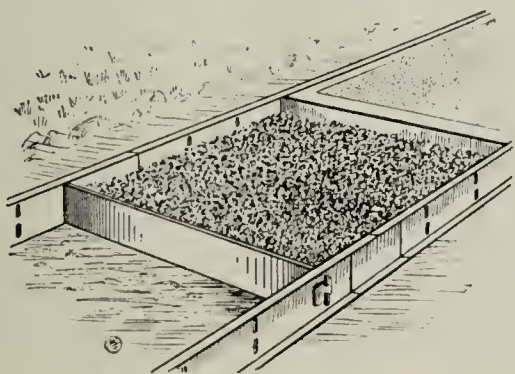
In conclusion it may properly be suggested that scientific study of the cost of burden in an undertaking that promises the attainment of new economies, for great reductions are possible in the cost of administration and operation of buying and selling, and in the maintenance and depreciation of plant. Thus in striving for more efficient production burden-saving methods are fully as valuable as labor-saving devices.

PRESSED STEEL FORMS FOR CONCRETE SIDEWALKS.

The pressed steel forms for concrete sidewalks, manufactured by the Berger Manufacturing Company, at Canton, Ohio, are made on a principle which is new and extremely simple. They have maximum strength and are 20% lighter than any other metal form.

These steel forms consist of rigid side rails, which are furnished regularly in lengths of 4, 6, 8 and 10 feet, but can be furnished up to 14 feet in length; cross plates, which serve the dual purpose of holding the side rails in place and also dividing the walk into the required sized blocks; 6-inch radius curves, for connecting intersecting walks and for the inside of curves, and flexible side rails for the outside of curves of any radius.

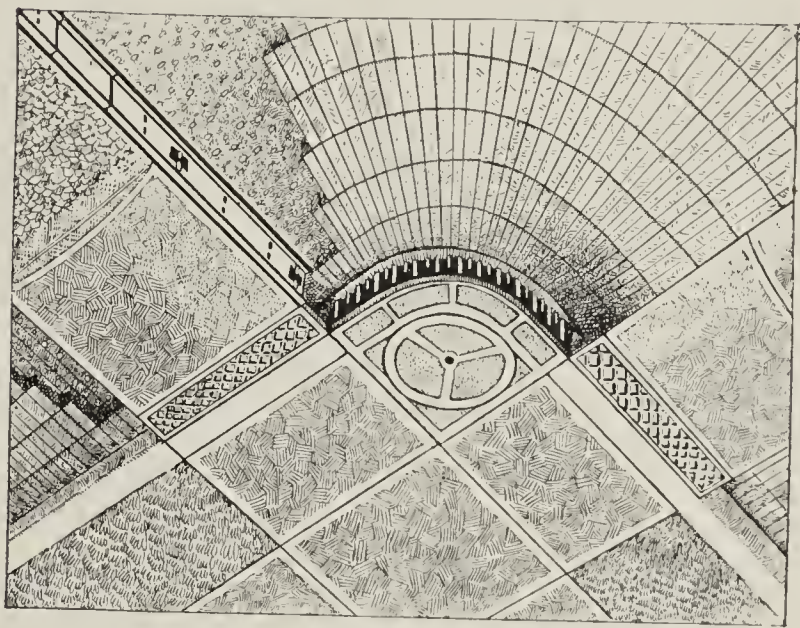
One end of each rigid side rail has a plain flange which fits into the lapped flange of the preceding length, making a concrete-tight joint through which it is impossible for the concrete to seep while tamping. The outside edges of these side rails are turned under so that it is impossible to cut the hands through careless or rapid handling.



Removing Cross Plates From a Completed Concrete Walk.—Concrete will not adhere to the smooth, clean surface of the cross plates as they are removed immediately after the concrete takes its initial set. This leaves a neat and perfect expansion joint and leaves each flag separate from, and independent of, the adjoining flags. This is a particularly valuable feature where frost is encountered.

The cross plates are made in lengths of $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$ and 5 feet, so that a walk can be laid any of these widths. The cross plates fit snugly into either the flexible or rigid side rails at the point desired to make a square block, and are held securely in place by means of a spring wedge.

The spring wedge makes a convenient, easy means



Cross Walks Constructed With Berger's Steel Forms

of securing the form, yet holds them so securely and rigidly that there is no possibility of their coming loose.

One reason these steel forms make the laying of concrete sidewalks easier and the finished job better is that there are no projecting rivet heads to interfere with the finishing tools. This is a feature that is readily appreciated.

These steel forms are furnished either four or five inches in height, so that a walk can be laid to either

depth. While light in weight and easily handled they are of ample strength, and withstand the rough usage incident to this work. Naturally, they can be used over and over again. They save time in laying, setting up and truing to line, and they save time in removing the forms. All that is necessary to take them apart is to remove the spring wedge holding the cross plates and side rails together. The concrete does not adhere to the smooth surface of the steel, and this leaves the concrete clean and smooth.

The Berger Manufacturing Company issue an interesting booklet on concrete sidewalk construction and these steel forms, a copy of which can be had by addressing them at Canton, Ohio, and mentioning Cement & Engineering News.

PORTLAND CEMENT AND CRUSHED ROCK.

The Choctaw Portland Cement Works, formerly of Oklahoma City, announces that its new plant at Hartshorne, Okla., is nearing completion and that its crusher plant has been in operation for seven months. The office building and machine shops have been completed and the steel has been erected for the coal mill, kiln building and grinding room, while work will soon begin on the foundations for the stockhouse. The office building is 28x28 feet, of cement construction, two stories high, and the machine shop is 100x40 feet, of fireproof cement and steel construction. The coal mill is 117x34 feet, and is equipped with three 30-inch Griffin mills, driven by a 100 horsepower motor. Modern equipment has been installed in the rock-crushing plant, the rock passing from the bins under the screen into tramway cars, which are operated by a continuous cable along a tippel 400 feet long to the raw grinding building. The company's rock loading tracks have a capacity for fifty cars. The material after passing through the driers will be emptied in sheet and concrete tanks, from which it will pass into two 7x9 ball mills, and from these into an 8x26 tube mill, one of the largest in operation. The dry kilns are eight feet in diameter and 110 feet long, the waste heat being utilized by passing it over vertical-tube boilers. The steam from these boilers is passed through turbines developing electricity to operate the entire plant. From the storage bin the clinker passes into a finishing mill, where it is ground by five 40-inch giant Griffin mills and carried by a conveyor to the block house, which will be of concrete and stone construction 140x75 feet. Sacking will be done by automatic sacking machinery. The company's deposits to be developed stand as a bare ledge 200 feet high and two and one-half miles in length, the shale lying immediately under the rock.

The Southwest Cement Plaster at Okeene, Okla., has become the property of four Wichita, Kansas, business men. The transfer was completed when negotiations were closed by J. H. McCallum for the plaster company and J. C. Fisher who is president of the new company. The general offices of the company are to be moved from Okeene to Wichita and located in the Beacon Bldg. The new company paid \$150,000 for the plant, (which turns out 200 tons of plaster daily).

The Utica Hydraulic Cement Company are to make a change in their manufactured goods, and on Monday will begin the manufacture of Portland cement instead of Hydraulic. Orders have already been received for 40,000 barrels of Portland and doubtless the company will soon be rushed to its full capacity.

GLIDDEN'S CONCRETE FLOOR DRESSING.

"How to Treat Concrete Floors," is the title of a neatly gotten up booklet describing the preparations put upon the market by the Glidden Varnish Co. of Cleveland, Ohio.

The publication gives, in the beginning, reasons for protecting concrete floors by the application of "concrete floor dressing" or "liquid cement" and, later on, gives detailed specifications answering the various conditions under which the concrete floors have been laid. As concrete floors are too frequently left unprotected and are mostly absolutely neglected, this book contains advice for all contractors, and should be read carefully.

The Glidden concrete floor preparations have proven of special value in hospitals and schools as well as factories and warehouses, owing to the fact that they effectually prevent the spreading of cement dust, due to abrasion and in this way have a special sanitary prophylactic value, as it is well known that the inhaling of cement dust has a most deleterious effect upon the health.

THE CHEMISTRY AND TESTING OF CEMENT.

The Chemistry and Testing of Cement, by Cecil H. Desch, may best be termed the first comprehensive review, written in the English language, of the research work done by the numerous cement chemists who tried to explain the constitution and the hardening process of cements.

The writer, on account of his knowledge of the English, German and French languages, is able to give an interesting resume of the most important essays published during the past 80 years, which time we may consider the period of scientific research of cement materials. The publication is up-to-date in every respect, embracing even the latest researches of the Carnegie Institution. 266 pages. Price, \$3.00.

CONCRETE FLOUR STORAGE BIN.

In Budapest a flour magazine to hold 22 million lb. is now in process of construction. The entire framework is of reinforced concrete. A concrete slab of the mixture 1:6, 6.6 ft. thick is used for the foundation. As the building is near the Danube precautions had to be taken against flood. The columns 13.2 ft. apart have a maximum safety load of 250 tons each, and go down to the foundation slab. The columns in the basement are 26x26 in. and reach to the ceiling without interruption. In each story they are connected by cross girders. The concrete slabs for ceiling are 3.2 in. thick. The entire height of the building is 117 ft. and the pressure on the ground below foundation is 30 lbs. per sq. in.—Zement u. Beton.

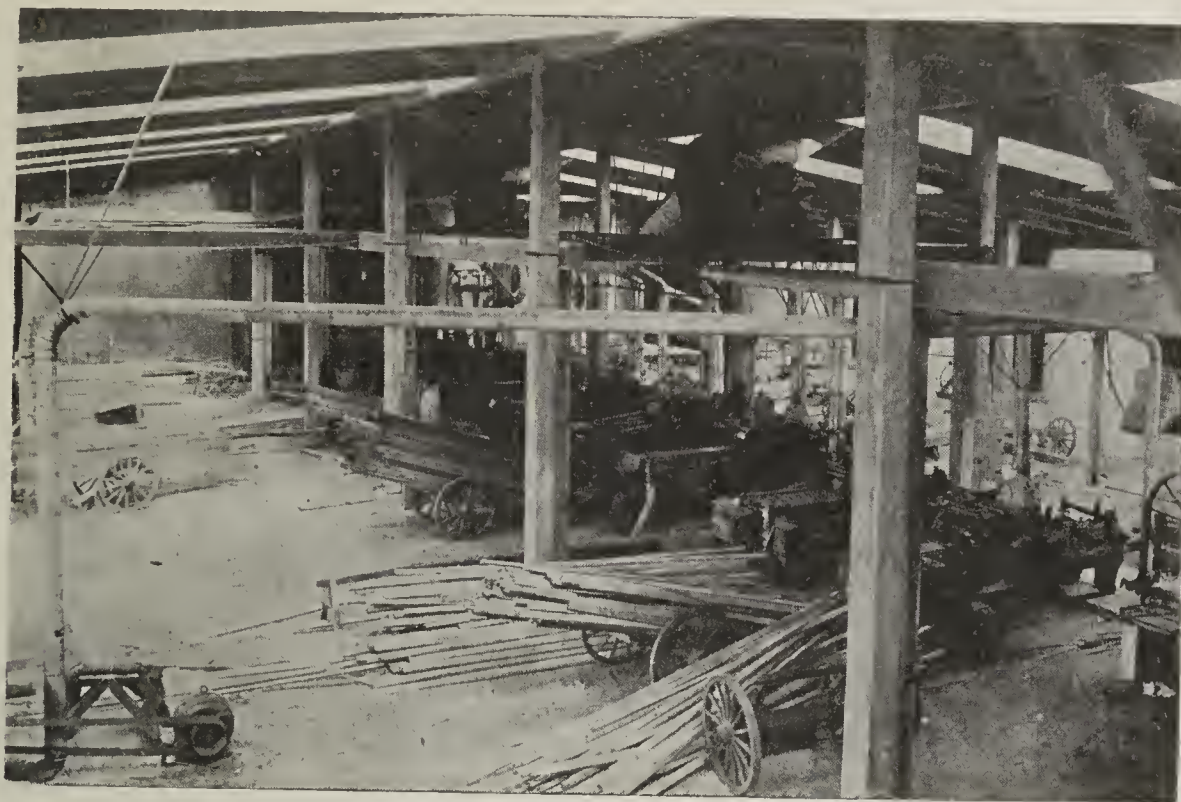
CEMENT BUNGALOWS.

Architects and home-builders have discovered, of late, that cement can be adapted to the construction of the bungalow with distinct success. Following this discovery, many bungalows of this kind are being erected in various parts of the country, and when skill and good taste are exercised in designing them, they present a very home-like and attractive appearance. Indeed, the indications are that cement will be one of the most common materials used in the construction of bungalows during the years to come; for the bungalow, as a type, has become firmly entrenched in the esteem of the people who desire simple and unpretentious homes, while cement has been established as one of the most valuable building materials known.—Suburban Life.

NEW CONCRETE MILL OF CROSS, AUSTIN & IRELAND LUMBER CO.

The accompanying illustrations show the new mill of the Cross, Austin & Ireland Lumber Company Brooklyn, N. Y., which has been built on the site of the old mill, destroyed by fire June 31, 1910.

The new building is of reinforced concrete throughout, is one story in height and has ample skylights. It has a few more machines than the former mill and is slightly larger. Aside from this increase in capacity there is no radical change in the layout of the plant. A special feature is the use of band saws for nearly every cutting operation, and each machine throughout the entire mill is driven by an individual motor. These motors are of the Westinghouse type CCL, squirrel cage top and aggregate 950 horsepower.



Interior View of Reinforced Concrete Saw Mill. Machines Operated by Westinghouse Individual Motors

During the past month the company has also placed in operation a sash and door factory equipped with 43 new machines, each one complete with its own individual motor. The motors are the same as those used in the mill, and aggregate 300 horsepower.

The complete plant is driven by a 650-Kw. Westinghouse-Parsons steam turbo-generator.

RUGGLES-COLES ENGINEERING CO.

The Ruggles-Coles Engineering Co. of New York recently designed a 3,000 barrel cement mill in which all the materials were separated by air. Ten Raymond mills were installed and gave a product of 96 per cent through a hundred-mesh sieve, and 91 per cent through a 200-mesh sieve. The cost of quarrying, transporting the materials through the mill on aerial tramway, crushing, storing, removing from storage, drying, grinding, pulverizing and delivering to the bins of the rotary kilns is 71 cents per ton.

CONCRETE PIPE AND TILE.

William Dicken, Fernie, B. C., has been engaged by the City of Medicine Hat to supervise the manufacture of concrete pipe for this season's work. Mr. Dicken has recently completed a contract for the supply of a large quantity of concrete pipe for the City of Fernie, B. C. The Fraser Valley Tile & Cement Co., New Westminster, B. C., are going to build a cement tile factory at Sopperton, B. C., and also one at Ladner, B. C.

NEWFOUNDLAND PEBBLES FOR CEMENT GRINDING.

A factor that bids fair to effect some reduction in the cost of the mill processes in cement making, is the discovery in Newfoundland, the oldest over-sea colony of the British empire—of pebbles suitable for use in tube mills for the fine grinding of raw materials and clinker in the manufacture of Portland cement. Heretofore the available supply has come almost exclusively from Denmark, Sweden, and other northern European countries, there being no known deposits of suitable pebbles in the New World, and the cost of transportation made the European pebbles expensive. The Newfoundland deposits, however, have the advantage of proximity to the American market, and the pebbles are said to have the essentials of high-grade

quality and durability. John W. Higman & Co., 112 Wall street, New York City, have made transportation arrangements for supplying the pebbles to cement mills in the United States.

NEWS ITEMS.

An Aurora, Ill., factory, the Luck Cement Post Molds Company, of which C. H. Klenze, of Davenport, is president, and J. G. Birtness, general manager, has been moved to Davenport, Iowa.

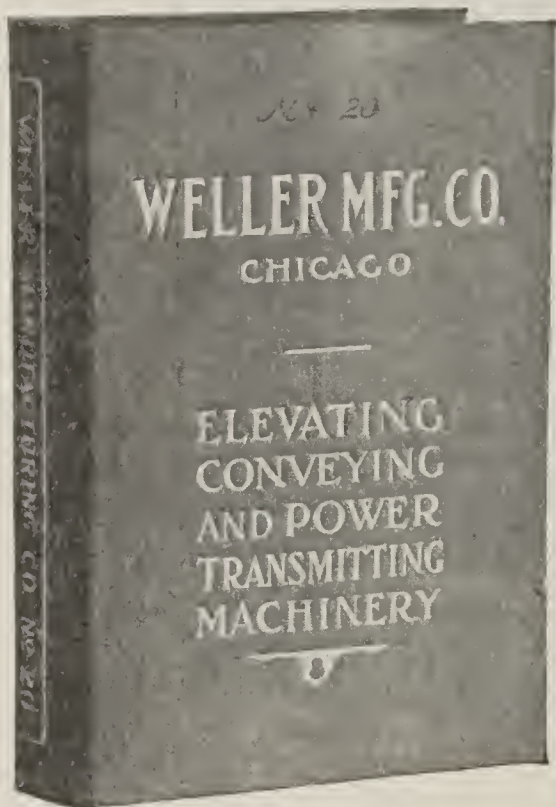
Cement telephone and telegraph poles as well as lamp posts are to be added to the output of the factory, which at present has a capacity of 1,000 fence posts daily. A large factory is now being built. The company was organized five years ago and has made cement molds and fence posts up to the present time. After the new factory is built and machinery installed, all kinds of poured cement products will be manufactured.

Notices are being sent out by some of the large Portland cement companies of the East, announcing a reduction of 10 cents a barrel in the mill price of cement, bringing it down to about 65 cents, which is within 5 cents of the lowest official price in the history of the trade. It is intimated that a further cut of 10 cents to 55 cents a barrel will be made, if this reduction does not bring the desired result.

SECOND EDITION OF NEW WELLER CATALOGUE NOW READY.

The requests for the new Weller catalogue were so numerous that the first edition was exhausted almost before it was off the press. The Weller Manufacturing Company report, however, that the second edition is ready for mailing and those of our readers who have not yet received a copy should write for one today.

This text book on elevating, conveying and power transmitting machinery contains 575 pages and is handsomely printed and bound in blue cloth covers. The size, and the arrangement of the various products, makes it very convenient for easy reference. It is without doubt one of the most complete books ever published on this class of machinery, and every present and prospective user of such equipment should have a copy.



CEMENT PRODUCTION OF CANADA.

Complete statistics have been received from the manufacturers of cement, covering their production and shipments during the year 1910. These returns show that the total quantity of cement made during the year including both Portland and slag cement, was 4,396,282 barrels, as compared with 4,146,708 barrels in 1910, an increase of 249,574 barrels or 6 per cent.

The total quantity of Canadian Portland cement sold during the year was 4,753,975 barrels, as compared with 4,067,709 barrels in 1909, an increase of 686,266 barrels, or 16.87 per cent. The total consumption of Portland cement in 1910, including Canadian cement and imported cement and neglecting an export of Canadian cement valued at \$12,014, was 5,103,285 barrels, as compared with 4,209,903 barrels in 1906, or an increase of 893,382 barrels, or 21.22 per cent.

A CONCRETE FLOOR 5998 FEET LONG.

The longest concrete floor in the world is probably that of the recently completed Armour-Swift-Burlington Bridge across the Missouri at Kansas City. This bridge is of unusual interest as it is the longest riveted truss in the world. The contractors by careful planning were able to mix all concrete with one Ransome mixer which was stationed on the shore with an extensive hoisting tower adjacent.

NEWS NOTES.

The McCarthy Improvement Company, of Davenport, Ia., will build the \$30,000 concrete bridge at Batavia, Ill., the contract having been sub-let by Eckman & MacKimmie.

C. E. Heaps, contractor of Moline, Ill., was awarded the contract to erect the new brick, concrete and steel gymnasium, to cost \$150,000, for the college of agriculture at Ames, Ia.

The Cement Products Company, Buffalo Center, Ia., will turn out principally drain tile this summer. They have taken several large contracts.

Roeder & Greenman, of Quincy, Ill., have been awarded the contract to build a handsome concrete fountain for the Woodland Cemetery Association.

The Illinois Concrete Steel Company, of Peoria, was awarded the contract to build the new bridge over Farm Creek, near East Peoria, Ill., for \$630.

The Aiken Cement House, an Illinois corporation with \$1,000,000 capital and a \$25,000 interest in Wisconsin, has filed a statement to do business in the state of Wisconsin.

Plans have been filed with the building department for the construction of a new grandstand to be built of reinforced concrete and steel columns at the Polo grounds for the New York National League Baseball Club. The new stand will be a double-decker affair, semi-circular, somewhat after the fashion of the former wooden one. The inner circle will measure 328 feet and the outer circle 534 feet. The seating capacity will be about 45,000. The architectural work is being handled by the Osborn Engineering Company, of Cleveland, Ohio. Work will begin immediately.

Work has been begun on the plant of the Tycrete Concrete Products Company, which is building on Oak street, between Thirteenth and Fourteenth, Louisville, Ky. The company is erecting a building of reinforced concrete and the cost will be \$10,000. All sorts of cement products will be manufactured. C. D. Moody, of this city, is president of the company.

The Bowling Green White Stone Company, Bowling Green, Ky., has installed a crushed stone plant and is making a success selling the stone for building purposes as well as for fertilizer. The good roads movement in Kentucky offers a fine field for the sale of crushed stone, and this will be emphasized as the work progresses.

CEMENTATION OF WET GROUND.

A most interesting method used in connection with shaft sinking or tunneling through water-bearing ground has been developed in the Pas-de-Calais coal district of France, which is termed "cementation." The coal measures of the district are overlain with bedded marls and chinks, more or less fissured, and the fissures in some places are so filled with water that ordinary methods of shaft sinking would fail. Heretofore, the freezing system has been successfully used, but the new cementation method can be employed at less cost. In one instance, the cost of cementation through 343 feet of water-bearing ground was \$13,200. Briefly, the process used by this company is to drill a set of holes in the water-bearing ground, six in number, arranged in a circle, surrounding the site of the proposed shaft, and then to pump a cement grouting through the holes until the fissures and interstices are filled. Shaft sinking is then proceeded with as it would be through ordinary rock strata. The system seems applicable to many situations where water is encountered in either shaft sinking or tunnel driving in broken rock.

An Inexpensive Rock Crushing Plant at Redondo, California

The rock situation has been one of the most difficult problems confronting contractors in the construction of Los Angeles county's "good roads" system. In the early stages of the work, through the delay of the supervisors in deciding upon the purchase of suitable quarries, there was a great dearth in the available supply, entailing great loss of time and money on the part of the contractors. Even now the situation is not the best.

In the construction of oiled macadam roads a suitable quality of crushed rock is one of the most important features. To the layman it would appear that in the many hills and mountains existing in Los Angeles county there is an inexhaustible supply of good material for crushed rock. As a matter of fact, however, rock of the desired quality for this class of road construction is not plentiful. Where suitable rock does occur in the majority of instances it lies in pockets of usually small quantity. What may appear to be a rich quarry may turn out after being worked a short time to be of very limited quantity.

To quarry this rock is a simple matter. No blasting is necessary, although small quantities of a mild explosive are used to loosen the boulders and render their loading in the dump wagons easier. A force of Mexican laborers was put to work piling the boulders on the hill side, hardly requiring the assistance of a pick to loosen them. The boulders are then loaded onto one-mule dump wagons and hauled down the hill to the crushing plant, located immediately at the base of the quarry.

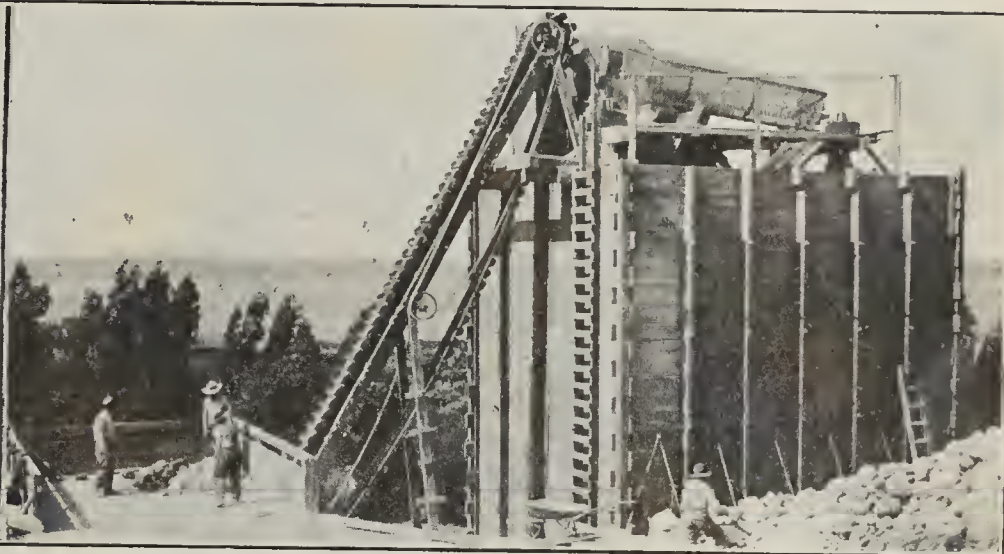
The crushing plant is simply designed and inexpensively built. It consists of a No. 11 Ft. Wayne jaw crusher taking rock as large as 14x28 inches. A jaw type crusher was decided upon so that the boulders could be fed into the crusher without the necessity of first breaking them up. Above the crusher was constructed a wooden platform onto which the dump wagons are backed and unloaded. Two laborers remain on the platform, feeding the boulders into the crusher mouth through a 14x28 aperture in the platform floor.

Below the crusher was built a frame storage bin, 20x50 feet, and thirty feet high, with chutes on the



General View of Redondo Rock Crushing Plant

Designed and Machinery Furnished by George A Rogers, Los Angeles



Platform Over Crusher, Screen and Storage Bins

When the improvement of the Wilmington-Redondo road was undertaken by the Highway Commission, some Redondo capitalists conceived the idea of utilizing a quantity of boulder rock lying in a hill east of Redondo near the thoroughfare to be improved. The rock was of a quality acceptable to the Highway Commission and a contract was ratified by the board of supervisors for the purchase of 20,000 tons of this crushed material at 87c per ton at the crusher. This contract will consume a large part of the available supply.

This quarry is one of unusually peculiar formation, consisting entirely of boulders averaging between six and twelve inches in greatest diameter closely embedded together in gravel and sand, the formation when opened appearing much like that of a boulder beach. The formation runs from the base of the hill up to the top, a length of about 1,000 feet, and is from 400 to 500 feet in width. The boulders and clean gravel bed averages in depth from five to eight feet covered with a thin layer of soil and wild sod. The boulders lie scattered protruding through the sod, these surface rock being of porphyry formation. Underneath this miscellaneous surface aggregate lies a solid layer of almost white boulders and clean sand and gravel, this layer averaging in thickness about five feet. The formation is the more peculiar in that it occurs in only this one hill, none of the surrounding hills appearing in any way similar.

road side for loading the wagons by gravity. A 40-ft. chain elevator conveys the material from the crusher to a revolving screen at the top of the storage bin. This screen is 42 inches in diameter and 16 feet in length. The crushed rock is separated into four sizes, each size falling into a storage compartment.

Above the crusher, on the hill side, is located the power plant, consisting of a 40 horsepower distillate gas engine. Water is obtained from wells in the valley a short distance from the plant. Water supply and oil supply are stored in corrugated galvanized metal tanks above the power house.

The plant is turning out a daily supply of crushed material ranging from 150 to 175 tons per day. With practically no extra cost for equipment this output could be almost doubled.

The cost of the entire plant and equipment complete was about \$6000 and will pay a handsome profit on the contract being executed for the Highway Commission alone, totaling \$17,400. The plant was designed by George A. Rogers of Los Angeles, who also furnished the machinery and all equipment. It is owned and operated by P. S. Venable, W. F. Sprinkel and A. B. Steele of Redondo.

The highway being improved with this crushed rock connects the city limits of Wilmington, on the Los Angeles Harbor, and the east city limits of Redondo, on the west beach. It is about eight miles in length. The construction contract is being executed by Leigh Garnsey, contractor.

CONCRETE POTTERY AND GARDEN FURNITURE.

By Ralph C. Davison.

This work should appeal strongly to all of those interested in ornamental concrete as the author has taken up and explained in detail in a most practical manner the various methods of casting concrete into ornamental shapes. The titles of the thirteen chapters of which the book is composed will give a general idea of the broad character of the work. The first two chapters explain a most unique and original method of working pottery which has been developed by the author. They are entitled: I. Making Wire Forms or Frames. II. Covering the Wire Frames and Modeling the Cement Mortars into Form. The remaining eleven chapters are as follows:

III. Plaster Molds for Simple Forms. IV. Plaster Molds for Objects Having Curved Outlines. V. Combination of Casting and Modeling—A Egyptian Vase.



Soulard Public Bath House, St. Louis, Mo. Pool, Floors, Steps and Walls Surfaced with White Cement containing Water-Proof Compound

VI. Glue Molds. VII. Colored Cements and Methods Used for Producing designs with Same. VIII. Selection of Aggregates. IX. Wooden Molds—Ornamental Flower Pots Modeled by Hand and Inlaid with Colored Tile. X. Concrete Pedestals. XI. Concrete Benches. XII. Concrete Fences. XIII. Miscellaneous, including Tools, Waterproofing and Reinforcing.

The chapter on color work alone is worth many times the cost of the book inasmuch as there is little known on this subject, and there is a large growing demand for this class of work. The author has taken for granted that the reader knows nothing whatever about the material and has explained each progressive step in the various operations throughout in detail. These directions have been supplemented with half-tones and line illustrations which are so clear that no one can misunderstand them. The Amateur Craftsman who has been working in clay will especially appreciate the adaptability of concrete for pottery work inasmuch as it is a cold process throughout, thus doing away with the necessity of kiln firing, which is necessary with the former material. The book is well gotten up and is printed on heavy coated paper and abounds in handsome illustrations throughout which clearly show the unlimited possibilities of ornamentation in concrete. 196 pages. 140 illustrations: Price \$1.50.

CEMENT TILE CONTRACT.

One of the biggest cement tile contracts in Illinois was let when the Raymond Cement Tile Company, Raymond, Ill., outgeneraled the vitrified tile men in the Union Drainage District and stepped away with a \$17,818 order. In order to impress the skeptical farmers as to the lasting qualities of the concrete, the makers gave a ten-year guarantee. The contract calls for 6,220 feet of 33-inch, 1,140 feet of 30-inch, 2,626 feet of 22-inch, 2,640 feet of 20-inch, 4,120 feet of 18-inch, 5,535 feet of 16-inch, 3,535 feet of 15-inch, 5,085 feet of 14-inch, 7,340 feet of 12-inch, 20,940 feet of 10-inch, 15,975 feet of 8-inch, and 9,180 feet of 6-inch.

The company has added 8,000 feet of floor space to its factory and installed machinery for making 16 to 33-inch tile at an expense of \$3,000.

The Illinois Cement Construction Company, of Springfield, Ill., was awarded the contract to pave School street in Hillsboro for \$24,564. The contract calls for Edwardsville brick, sand cushion, concrete foundation and concrete retaining curb.

CEMENT DUST.

Orange growers in the vicinity of the big mill of the California Portland Cement Company, at Colton, Cal., recently secured a court injunction ordering the company to shut down its plant within two months, on the ground that the cement dust from the mill was injurious to the older established fruit growing industry.

The company is now, at very great expense, installing means to prevent discharge of dust from its plant and thus remove all cause for complaint. A device similar to that used in big buildings to cleanse the office and factory air used for ventilation, is to be employed. A series of nets and water sprays will catch the cement and lime particles that now drift out into the atmosphere and settle on the fruit groves.

The Standard Portland Cement factory at Leeds, Ala., is running to the full extent of its capacity, with orders on hand for the remainder of this year. A Tennessee company alone is taking 12,000 barrels a month out of a total of 36,000 barrels, which is the monthly output of the plant. The capacity of the plant is to be enlarged as soon as the owners can get the time to have the work done. That time is very indefinite under present circumstances.

HOW STEEL BINS AID IN FIRE PROTECTION.

The matter of fire protection is of the utmost importance in every business, but it is a striking fact that thousands of merchants and manufacturers take no cognizance of the necessity of this protection.

These are the men who, after the disaster that comes unexpectedly upon them and overwhelms them, ruefully look back upon their old-time optimistic complacency and condemn themselves for being too narrowminded to fortify and protect themselves against the fiery foe.

Such examples as these have opened many eyes, and to the doctrine of forethought is due much of the success of steel. Business men, heeding the necessity of protection against every untoward contingency, are building bulwarks of steel about them. They have discarded wood and others are following their example.

So, as the transition progresses, it reaches out into every office, store, factory, warehouse, jobbing house and so on down the list. The cry on every hand is "Fireproof—it must be fireproof!" Business men demand fireproof buildings because they want their property, their stock, their business thoroughly protected.

An essential in this all-around fireproofing is the discarding of everything that is a fire contributor. One of the latest and newest products of this kind placed on the market for store, factory and warehouse fixtures is the steel bin, manufactured by the Berger Mfg. Company, of Canton, Ohio.

Steel bins are coming into favor for storing small stock of every description in bulk. Hardware dealers and other merchants are using them, while they are being introduced into many factories where it is essential that small parts be kept conveniently at hand. They are constructed of steel and reinforce the other steel construction of the building, for they do not feed flames but do assist in the general plan of protection.

One of the biggest manufacturing companies in the great Pittsburgh industrial district long ago adopted a plan something like this, of having steel compartments in a great room, protected on all sides with steel—like a gigantic vault—for the storage of valuable blue prints.

With the increasing appreciation of the nature of concrete design and of the details of concrete construction, there is growing a like increase in the use of concrete for residence buildings. To the casual observer, this growth may not be apparent because of the still great proportion of brick, stone and frame houses in our less densely settled districts, but it is a fact that the numerous advantages to be expected from a concrete house are recommending it to many owners. The two books noted above are testimony to this growth. They give upwards of 200 examples of concrete residences, varying from country mansions costing hundreds of thousands of dollars to the two or three-room bungalow of recent popularity. Each house has a page devoted to it, with a half-tone view and in most cases floor-plans appended.

It is an encyclopedia of what you ought to have, at prices you can afford to pay.

CEMENT SILOS THE BEST.

According to reports sent out from the Agricultural College, the experts from that institution have decided that the cement silo is superior to the old stave silo, and that the cost of the former is no more than that of the latter. The cement silo is not affected by hot winds, dry weather, and rats, as is the stave one. Neither will it burn down as readily, and its durability is practically without limit. The cement silo when properly reinforced with metal, lath, and wire does not crack. More than 50 of these silos, according to the report, have been built in Kansas this year under the direction of the experts from the college who do not charge anything for this service but their expenses.

A 100-ton silo of the cement kind has just been completed at the college at Manhattan, two more will be started next week at Hays, and one a little later at the station at Dodge City, says the Kingman (Kansas) Journal.

There is no doubt that the silo is the coming great improvement on the Kansas farm. And Kingman county farmers are learning it fast for a great number of silos are going up, especially near Murdock, Basil, and Rago, and possibly other parts of the county from which we have not heard. We venture to predict that the silo movement means more to the prosperity of Kingman county than any other thing that has been started in two decades. Even the most unfavorable year produces worlds of feed to fill a silo. And the man with a silo full of the choicest feed and a bunch of cows (real genuine selected dairy cows) has a sure living, and more, in sight, regardless of how the wheat and corn turns out. Along with the silo will come milk condenseries and other demands for dairy products.

It is stated that the cost of erecting the cement silo at the agricultural college, mentioned above, was as follows:

Cement, \$46.50; metal lath, \$23.68; lime, \$1.50; wire, \$3.69; iron rods for doors, \$2; gas pipe for reinforcing at doors, \$3.36; lumber, \$5.04; rent of scaffolding, \$8; labor of plasterer, \$38.25; labor of carpenter, \$14; common labor, \$46.50; sand, \$11.20; miscellaneous expenses, \$4.30. This makes a total of \$208.02, but the foundation of this silo had been previously built, so that cost, probably \$35, was not added to this estimate.

We should be pleased to know how this cost compares with the cost of either cement or stave silos erected here in this county, and will gladly give space to any of our readers who care to report their experiences in silo building, for few things will be of greater interest to farmers for the next few years than this question of the silo, its cost, and its benefit.

AETNA PORTLAND CEMENT PLANT.

That the Aetna Portland Cement plant is producing cement in record breaking quantities is attested to from the fact that all previous records were broken for the month of May when the output was 33,386 barrels. This is an average of over 1,000 barrels per day, something that has never before been accomplished in the history of the plant. Superintendent Simmons under whose careful management these remarkable figures have been produced is deserving of congratulations on the excellent showing made. While Mr. Simmons has been in charge of the plant little over a year, yet he has been successful in increasing the output to the highest figures in the history of the plant. The plant is in the best shape now that it has been in several years and is capable of producing not only more cement, but of higher quality, also a fine compliment to the new superintendent.

POPULAR HAND BOOK FOR CEMENT AND CONCRETE USERS.

The Popular Hand Book for Cement and Concrete Users, by Myron H. Lewis and Albert H. Chandler, is an excellent book of reference for the practical man who desires to study the best methods of mixing concrete and using it. The various tools and designs of forms for ornamental work are described in simple language and fully illustrated. Concrete block construction, concrete in railroad construction, concrete on the farm and waterproofing of concrete structures are several of the most interesting chapters of this publication. 420 pages. Price \$2.50. Sent by us on receipt of price.

REINFORCED CONCRETE PIPE.

The St. Joseph (Mo.) Reinforced Concrete Pipe Company have closed contracts for a large amount of its reinforced concrete pipe for sewer purposes. Several carloads of the pipe have been shipped to Omaha, Neb., where it is to be used in the construction of sewers. Thousands of feet of the pipe is also being sold for culvert purposes, many county courts throughout the state having adopted its use in the building of culverts.

The great advantage of using reinforced concrete pipe is found in the fact that it gets stronger and better as it remains in the ground, while at the same time it is cheaper than any other material used.

CONCRETE BRIDGES IN KANSAS.

Many Kansas counties are building bridges of reinforced concrete under the direction of the state highway engineer. In Coffey county the engineer's men are assisting the people in building concrete jetties along the Neosho river for flood protection. Prac-

tically every county is putting in good types of reinforced concrete bridges. In Wabaunsee county one reinforced bridge cost \$855. It has a 20-foot span carrying a 16-foot driveway. The materials for this bridge were hauled about 20 miles. Another bridge of the same kind cost \$895, and these bridges are made to carry a 24-ton engine. The approaches are tested to stand a very heavy strain.

Horlick's Malted Milk Company, of Racine, Wis., has commenced the erection of a large reinforced concrete office and warehouse building. The structure will be four stories high, 100'x100', with a wing measuring 30'x70' in dimensions. The building will be strictly fireproof, reinforced concrete being used throughout. The exterior will be faced with brick. The structure will cost \$100,000.00.

The American Concrete and Street Railroad Tie Company has opened offices in the Central National Bank Building, Birmingham, Ala. The concern is headed by B. M. Bullard, president, and W. R. Powell, secretary and treasurer. The company will build in the suburbs a \$150,000.00 plant for the making of concrete railroad ties. It will cover about five acres, and the company will employ about five hundred men. The officers state that the company's arrangements with various railroads justify a capacity for their plant of 2,000 ties daily. The product of the new concern is a patented tie, made in two parts and connected by a steel binder. The separation of the tie in the center assures a flexibility not secured by other patented ties, and this difficulty discouraged the manufacture of previous designs, as their rigidity was very destructive to rolling stock. The cost of the new tie will be only a fraction more than that of the wooden ones.

CERESITIZE YOUR CONCRETE CONSTRUCTION

Concrete and cement mortar can be permanently and effectively waterproofed with a treatment of Ceresit Waterproofing—for water will not penetrate where Ceresit is. Many years of practical tests on important engineering projects have proven the water-repellant properties of Ceresit so that we can guarantee absolute satisfaction where it is used under our direction.

Ceresit is an integral waterproofing in paste form, which is put into the water intended to be used in mixing concrete or cement mortar.

When so mixed it permeates uniformly the whole mass through and through, and neither scratching nor chipping the surface will injure the waterproofing quality of the mass.

Ceresit always protects concrete against disintegration from frosts.

Ceresit has been used with success on many important engineering projects. Tunnels, dams, reservoirs, foundations, swimming pools, tanks, water towers, boiler pits, building walls, viaducts, aqueducts.

It has also been widely and successfully used for waterproofing and dam-proofing, cement mortar coating on structures built of concrete, brick, stone and tile, and on stucco and cement plaster surfaces.

Ceresit does not affect the tensile strength nor change the color of concrete or cement mortar.

GUARANTEE BOND.—When the importance of the work justifies, we will give a bond to back our guarantee that Ceresit is a permanent, effective waterproofing.

"Ceresit"
Waterproofing

THE PERMANENT WATER REPELLANT

should not be confounded with mere surface paints and washes which do not bond properly and soon chip and peel off, allowing the water to get into the concrete and cement mortar.

Ceresit is catalogued in "Sweet's" Index, pp. 46-47

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MCARTHUR BUILDING

Architect
J. H. G. Russell

Winnipeg,
Man.

Basements waterproofed
by 1/2-inch cement mortar
coat with Ceresit.



A LITTLE STORY ABOUT TILE.

Once upon a time there was a farmer whose land needed tiling about as badly as his town dealer needed money. There was only one obstacle to the bargain—and that was the cost of the tile. The farmer said it was prohibitive, and the dealer replied that the manufacturer's charge to him was worse than that.

So the farm went untilled—and a good bit of it untilled, too, in consequence. And neither the farmer nor the dealer could see a way out.

One day, a few months later, the dealer tried a new invention that made tile from ordinary materials on anybody's sand lot—and claimed to make it better than the high priced clay tile. He ended by buying it—the Cardiff Cement Tile Machine, made by the Leavitt Mfg. Co., Box E, Urbana, Ill., and advertised elsewhere in this issue.

Then he sent for the farmer, and surprised him by a price on tile that nearly took the latter's breath away. Then the farmer saw the machine. He was interested, and the dealer explained just how it worked.

Then the farmer surprised the merchant. He asked him to set a price on the machine. The other hesitated—did a quick bit of hard thinking—and did so. The farmer bought it on the spot.

The rest of this story is a matter of arithmetic—and is up to the Leavitt Mfg. Co. to vouch for. Inside of a few weeks the dealer had disposed of several of these machines at a profit larger than their daily output would have given him in many weeks—and the farms within many miles of that town in all directions were being rapidly equipped with bright, durable tile at a low cost.

The moral appears to be that a low cost may sometimes mean also a larger profit. At least in tile.

USE CONCRETE SNOWSHED.

The first concrete snowshed ever constructed has just been finished in the heart of the Cascade mountains, on a stretch of road near Scenic Hot Springs slides.

The Great Northern, like the majority of western railroads, has a number of timber sheds, but this road is protected throughout every place where it is possible for a slide to occur, and in order to obtain the best known protection it has in one place decided upon concrete construction.

This snowshed cost \$500,000 and more than 400 men were employed in building it. It is 3,900 feet long and 24 feet high on an average. The ten-inch thick roof is supported by concrete pillars at intervals of 12 feet, and the back wall is from 9 to 11 inches in thickness.

When snow sheds of whatever material are properly prepared they are built so that they do not obstruct the fury of the slide, with the sloping roof, the highest part of which is toward the mountain. In other words, they are constructed so that when the snow descends with fury, it slides over the top of the waiting shed and away from the tracks.

The shed just finished is anchored directly to the rock and makes a semi-artificial rock, which appears as part of the mountain. Where the back wall of the shed is attached to the rock it is fastened with steel bars extending into the rock.

Another advantage in this concrete construction is the ability to leave the front of the shed open in summer so that the scenery is unobstructed and the tunnel is light. In winter it can be closed if desired, as a board side will prevent the snow from drifting on the tracks.

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The Most Economical Sprocket Wheels on the Market

Last several times as long as ordinary cast-iron wheels, and cost but little more

Are accurately fitted to the original "Ewart" chains, of which we are the designers and makers



Life of chain prolonged, because wheels are not rapidly wearing away from the proper pitch diameter

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Trade Mark. Reg. U. S. Pat. Office

The economy resulting from the use of these wheels appeals to all who appreciate durability and satisfactory service, and especially to those who wear out machinery rapidly in handling Raw Materials in Cement Mills, Phosphates, Crushed Stone, Ashes and other abrasive materials

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PHILADELPHIA

CHICAGO

INDIANAPOLIS

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299 Broadway

PITTSBURGH
1501-3 Park Building

ST. LOUIS
Central Nat. Bank Building

SEATTLE
E. G. Brabrook

DENVER
Lindrooth, Shubart & Co.

NEW ORLEANS, Wilmot Machinery Co.

BUFFALO, 601 Ellicott Square

BOSTON, 131 State Street

Concrete Garage

The often quoted old-time absurdity of "locking the stable door after the horse is stolen," is almost equaled by the too frequent custom of storing costly automobiles in wooden structures. No matter what care is exercised, a considerable amount of oil must needs fall upon and be absorbed by wooden floors. Besides, this condition of the floor produces a decidedly deteriorating effect on rubber tires. A wooden garage means high insurance premiums, as many have learned to their cost.

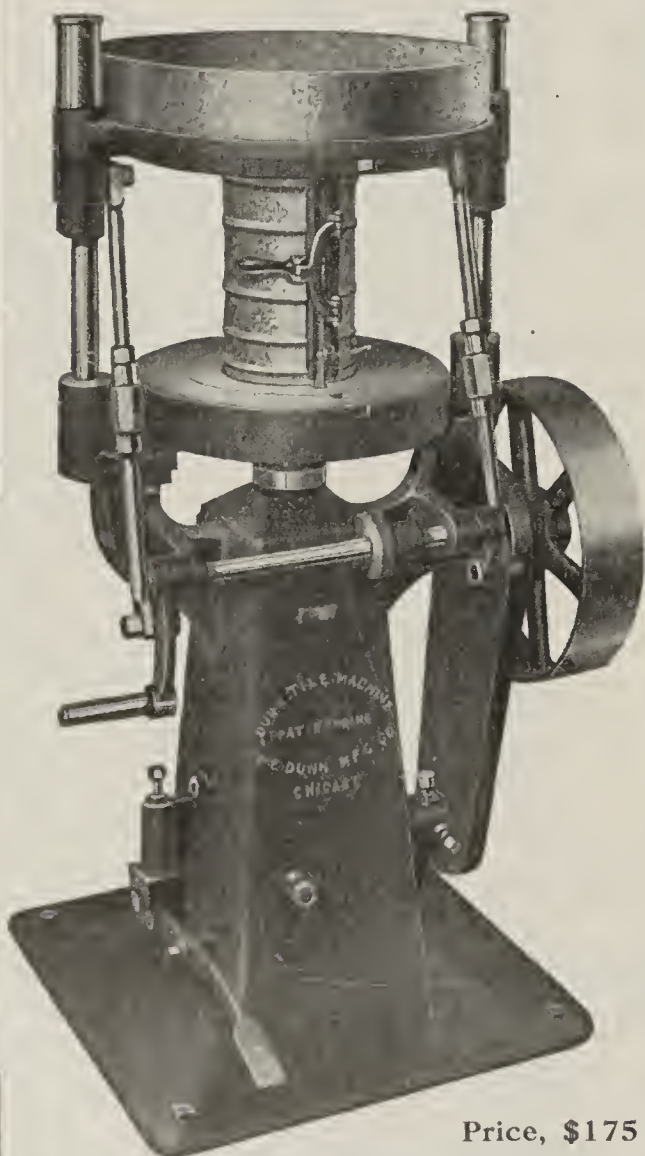
As ordinarily constructed, garages call for skilled labor to a much greater extent than do those built of concrete. A plain single-story garage can be constructed without elaborate plans under the direction of a competent foreman, and this is being quite extensively done. A building of more than one story or one elaborate in design, of course calls for a competent architect or engineer entirely familiar with the different phases of concrete construction, especially so when reinforced concrete floors are called for.

From the standpoint of wonderful development the automobile is keeping pace with that of concrete construction, and it seems peculiarly appropriate that one should provide the housing for the other. This is strongly emphasized by the circumstance that the automobile is invading the farms and villages of the country, where elaborate and costly garages are not constructed or desired. The American farmer is usually accustomed to the use of tools, with which he is well supplied and frequently himself constructs the smaller buildings on his premises. This has become more the rule since he became familiar with the nature and employment of concrete. Even if he lives in a section of the country where lumber is plentiful he

would still be foolish to employ it in constructing a building in which to house his automobile. He is fast finding this out and the circumstance is doing much to permit the enormous increase in Portland cement production now so much in evidence.

Five different methods of constructing concrete garages are now distinctly popular, and are used singly and in various combinations. These are: mass or reinforced concrete; concrete hollow tile; concrete block; pipe frame with wire lath and stucco; wood stud frame and stucco. For such construction intelligent and practical suggestions are made by some of the larger cement manufacturers, and these can readily be secured by those wishing to build substantial fire-proof garages at a small cost for material and less for labor.

These suggestions, it should be understood, apply only to small and simple garages, the construction of which is no more difficult than that of other small buildings. People sometimes undertake to act as their own architects and builders where they wish to erect garages and other buildings that call for vastly more technical knowledge than they possess. Save in exceptional cases, where one is especially well informed or possessed of something like genius, this is a distinct mistake leading not only to disappointment on the part of ambitious amateur architects and builders but tends to bring discredit on Portland cement. Builders of garages should exercise judgment and not attempt building feats that are beyond their powers. Those in a position to buy and maintain a costly automobile can afford to employ a competent builder to construct for them a garage that goes beyond a simple form.



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CEMENT

... AND ...

ENGINEERING NEWS



The Bosworth—All Concrete Building. See Page 395.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

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JOHN F. WALDRON - - - - - Advertising Manager

CHICAGO, DECEMBER, 1911

THE PROPER PERUSAL OF CONCRETE LITERATURE.

Under the headings "The Menace of Concrete," "Concrete in Building Works" and "The Danger of Concrete Construction," several of our contemporaries, for instance, "Stone" and "The Clay Worker," publish lively descriptions of the failure of the Austin Dam and of similar concrete work which collapsed or turned out to be unsatisfactory several months or years after having been completed.

These periodicals, which advocate the use of hewn stone and brick, ascribe, of course, all failures to the intrinsic properties of concrete which, in their opinion is utterly unfit to take the place of the old-time building materials. They do not go to the trouble of analyzing what share of the disaster has to be attributed to faulty concrete or to other factors, as for instance carelessness in selecting a proper foundation for the construction or negligence on the part of the contractor in doing the work, which would have caused other building material to fail as well. Nevertheless, these contributions by the opponents of concrete construction are well worth reading and should be studied with as much zeal as the numerous articles in our weekly and monthly magazines praising concrete in the highest terms.

Thus, we take the standpoint that all literature published with a view to exposing the defects of concrete construction, is equally apt to teach us a lesson as our text books and monthly publications dealing with its merits, and refrain from denying statements made in similar "inimical" magazines, as some of our subscribers wish us to do.

Only by studying carefully everything published in our technical magazines pro and contra concrete construction can the contractor become acquainted with the possibilities of concrete construction and accustom himself not to overestimate its qualities.

The numerous magnificent constructions in concrete

erected during the past half century all over the world are eloquent proof for the adaptability of concrete to all classes of architecture. They show that concrete possesses properties not to be found in other building material which make its application attractive from many points of view. But, for this very reason, the student of concrete construction should be especially watchful and try to familiarize himself with the mistakes still commonly made. This will further our general knowledge of the subject and help to propagate the use of concrete.

PENNSYLVANIA RAILROAD USES CONCRETE POLES.

To avoid interruptions by severe storms, or fires from meadow grass, as well as for durability and appearance, the Pennsylvania Railroad has constructed a reinforced concrete pole line designed to carry 60 aerial wires and two 1½ inch diameter lead encased cables for its telegraph and telephone circuits on the north side of its tracks across the five miles stretch of swampy meadow land between Manhattan transfer and the portal of the tunnels leading into the new passenger station in New York City.

Although the concrete poles were something of an experiment, and were more costly than wooden ones, it was evident that the latter would have been inadequate, while the former were sure to provide a safe and durable construction. Accordingly, a special yard was established near the line for making and seasoning the poles, which were turned out at the rate of about six a day.

Two hundred and two poles were required in this section. On account of numerous railway and highway crossing the spans vary from 70 to 135 feet, with an average span of 120 feet. The poles are from 35 to 65 feet in length and rise from 25 to 50 feet above the ground. On account of the softness of the earth, the concrete poles had to be supported by specially constructed artificial foundations.

On the south side of the tracks 50-foot steel poles are used to carry the wires for the transmission of traction energy from the tunnel portal to Harrison sub-station. They are placed 300 feet apart and are designed for not only the present needs, but to carry seven additional transmission circuits which may be required in the future. These steel poles are supported by concrete foundations built on the top of groups of from 60 to 90 foot piles driven down through the earth.

Overhead wires are used in crossing the Hackensack River instead of submarine cables in order to preserve the integrity of the line against lightning disturbances and to provide for the use of 33,000 volt transmission.

To do this it was necessary to maintain the clearance prescribed by the War Department, which involved the construction of two high steel towers. The line approaches the river on 50-foot poles, rising to an intermediate 70-foot pole, and then directly to the tower, 181 feet 4 inches above high water. The wire span over the river has a length of 765 feet.

ANCIENT REINFORCED CONCRETE.

A recent examination of the roof of one of the numerous ancient tombs along the Appian Way, between Rome and Brindisi, Italy, revealed the construction of a roof slab made of hydraulic cement, reinforced with bronze rods crossing each other at right angles, thus forming a lattice reinforcement.

The Edison Roll Crushers

By W. H. Mason.*

The rapid growth of concrete construction in this country is causing unusual interest in the manufacture of cement, most of which is made from broken stone which also constitutes about two-thirds of the bulk of ordinary concrete. This paper discusses the Edison method of quarrying and crushing stone, both for the manufacture of cement and for concrete, railroad ballast, macadam, etc.

Some years ago, Thomas A. Edison experimented with the concentration of a very lean magnetic iron ore at Edison, N. J., employing the usual plant for crushing stone, which consisted of several jaw crushers. The stone in the quarry was drilled with a close spacing of drilled holes, and after being blasted was broken up by hand sledging into pieces of approximately 100 lb. in size. This caused a large expenditure for drilling, dynamite, hand sledging and hand loading. Mr. Edison soon realized that in concentrating this lean iron ore commercially it was necessary to reduce the cost of quarrying and crushing to a much lower point than had been realized heretofore in operations of a similar character, for in order to produce one ton of concentrates it was necessary to quarry, crush and treat about four tons of the lean ore.

In approaching this problem, Mr. Edison reasoned "the total heat or energy in 1 lb. of pea coal is approximately 12,500 heat units, but only about 15 per cent of this, or 1875 B.t.u., is available in mechanical energy through the medium of boilers and steam engines, while the available B.t.u. in 1 lb. of nitro-glycerine is approximately 3650. Therefore, in 50 per cent dynamite there is available 1825 B.t.u. per lb. or the same mechanical power that can be derived from 1 lb. of coal. But 1 ton of pea coal is worth approximately \$2.50, while 1 ton of dynamite is worth about \$250, making the commercial advantage of the coal over the dynamite approximately 100 to 1."

Realizing also that a large part of the dynamite used in ordinary quarrying operations was expended not so much in breaking out the stone from the ledges in the quarry, but in reducing this stone to such sizes as could be handled in the crushers, he set out to design a crusher capable of taking much larger stone. He first constructed a pair of rolls 5 ft. long and 6 ft. in diameter having small protuberances on the surfaces, as shown in fig. 1. This would take and crush larger pieces than the jaw crushers then in use, but if a stone were fed to the rolls greater than the angle of grip of the rolls, it would ride on top and rapidly wear down the knobs on the plates or tear the plates from the surface of the rolls.

Mr. Edison then invented the slugger, consisting of two rows of high knobs on one roll set diametrically opposite (fig. 2). These knobs were put on with the idea of mechanically slugging the larger stones to such a size as to come within the angle of grip of the rolls. He had found that the rolls would frequently stop on receipt of a large charge of stone, not having sufficient power to crush the rock. To remedy this he ran the rolls at a much higher speed than when they were first erected, storing up sufficient kinetic energy to perform the actual crushing operation. This increase of speed accomplished two purposes: it in-

creased the kinetic energy and delivered a much harder blow from the slugging knobs.

When the rolls receive a stone larger than they can grip, it tends to ride on top of the rolls, but the slugger prevents this, since it delivers 440 blows per minute and the stone must rise two or more inches in

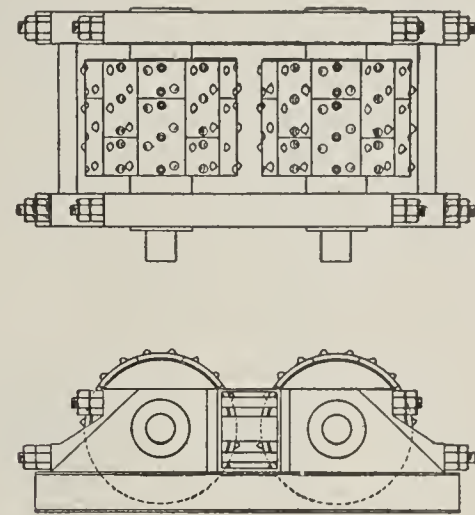


Fig. 1. Original Rolls Patented in 1895.

approximately one twenty-fourth of a second or be shattered.

The rolls were designed primarily to reduce the expense of quarrying, which is usually much larger than the crushing costs, whatever type of crusher is used. In order to do this, it was necessary to set the drilled holes far apart and to blow out the stone or ore in large pieces, thus making a great saving in both drilling and blasting. Mr. Edison also had especially constructed two steam shovels, much heavier than any previously built and special cars to load, trans-

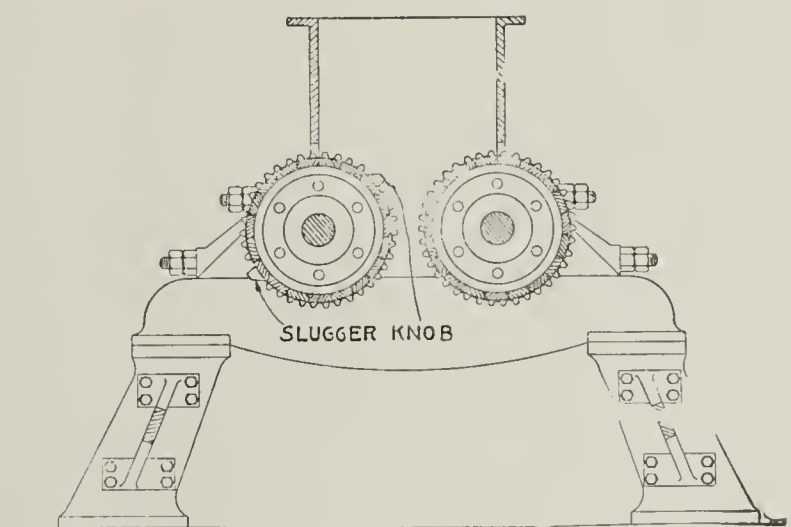


Fig. 2. Original Rolls with Sluggers Added.

port and dump these large pieces of stone into the rolls. With this combination it was possible to reduce the cost of quarrying and crushing to about one-fourth of what it had been when using the jaw crushers. About the time these improvements in quarrying and crushing were made, the development of the Mesaba iron ore deposits caused such a reduction in the price of iron ore that the Edison plant, with its extremely low-grade ore was unable to compete.

*Reprint from Journal of American Society of Mechanical Engineers.

Having developed these crushing rolls and much other machinery for handling and milling ore or stone, Mr. Edison subsequently projected the Edison Portland Cement Company and there installed the set of 5 ft. by 5 ft. rolls shown in figs. 3 and 4. These views show the general arrangement of the crusher house, containing 4 sets of rolls, which reduce the stone successively from pieces weighing 8 to 10 tons to $\frac{1}{2}$ -in. chips. This crushing plant has been in operation for 8 years.

shovels now manufactured. It is an ordinary occurrence, however, to crush a stone weighing over 15 tons.

The cement stone quarry of the Edison cement plant is an open cut with the strata running vertically or approximately so. The stone rises from 60 ft. to 80 ft. above the floor of the quarry, with a 3-ft. or 4-ft. layer of clay on top, which is removed by a small revolving steam shovel and loaded into carts. Holes are drilled with a churn drill from the top of

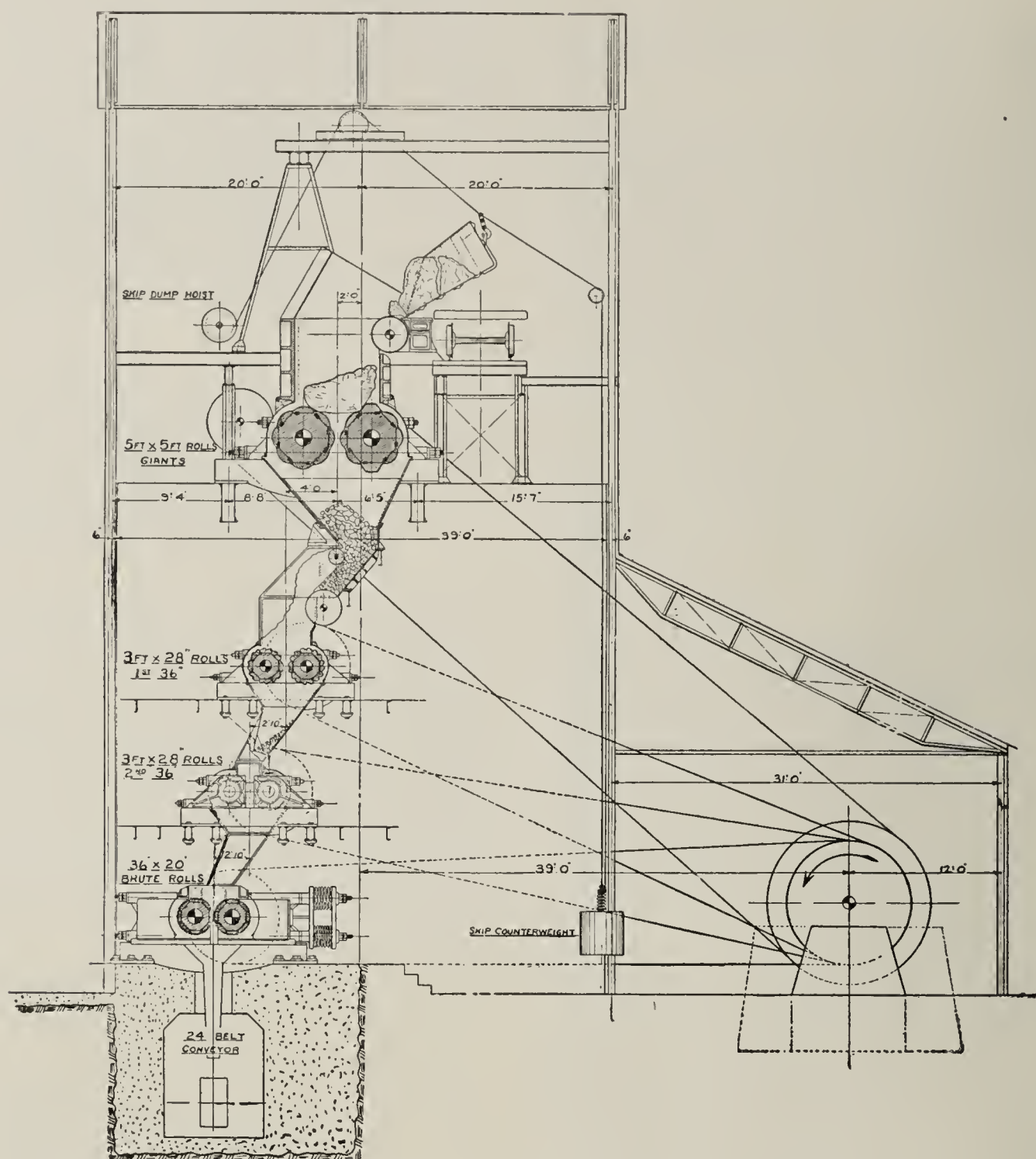


Fig. 3. Sectional View of the Crushing Plant of the Edison Portland Cement Company.

Before Mr. Edison constructed his giant rolls, the largest rolls in use were those known as the Cornish rolls, which were geared together. The kinetic energy of a pair of these rolls, 16 in. in face, 30 in. in diameter and 100 r.p.m., is 8100 ft-lb. The kinetic energy of a pair of 5 ft. by 5 ft. Edison, 220 r.p.m. rolls is 2,280,000 ft-lb. The kinetic energy of a pair of Edison rolls, 6 ft. in diameter 7 ft. long at 175 r.p.m., is 4,217,000 ft-lb. The largest gyratory crusher that the writer knows of has a 42-in. opening; that is, it will take a stone something less than a 42-in. cube, while the Edison 6 ft. by 7 ft. giant rolls will take a stone about 7 ft. cube. The 42-in. cubic stone weighs approximately $3\frac{1}{2}$ tons, while a 7-ft. cube weighs approximately 28 tons, which is probably larger than can be handled economically by the largest steam

the quarry to about 6 ft. below the floor. These holes are 6 in. in diameter and about 20 ft. apart and set back about 20 ft. from the face of the quarry, which is worked on two sides, at A and at B. On account of the stratification, indicated in fig. 5, it has been found necessary to use more dynamite when working face A than when working face B. While working B the holes can be spaced at least twice as far apart when using the same amount of dynamite in each hole as in those on face A. When a hole is drilled it is usually squibbed in the bottom by putting 30 to 50 lb. of dynamite in the bottom of the hole and exploding it. This enlarges the bottom of the hole, making room for more powder at this point. Then the holes are loaded with 50 per cent dynamite, which fills up the portion which has been squibbed and runs

up to about the level of the quarry floor. From this point to within 30 ft. from the top of the quarry the hole is loaded with 30 per cent dynamite. The remainder is tamped only, no powder being needed, since the explosion will shear off the top 30 ft. From 400 to 800 lb. of dynamite is put into each hole, and is then detonated by connecting the electric explod-

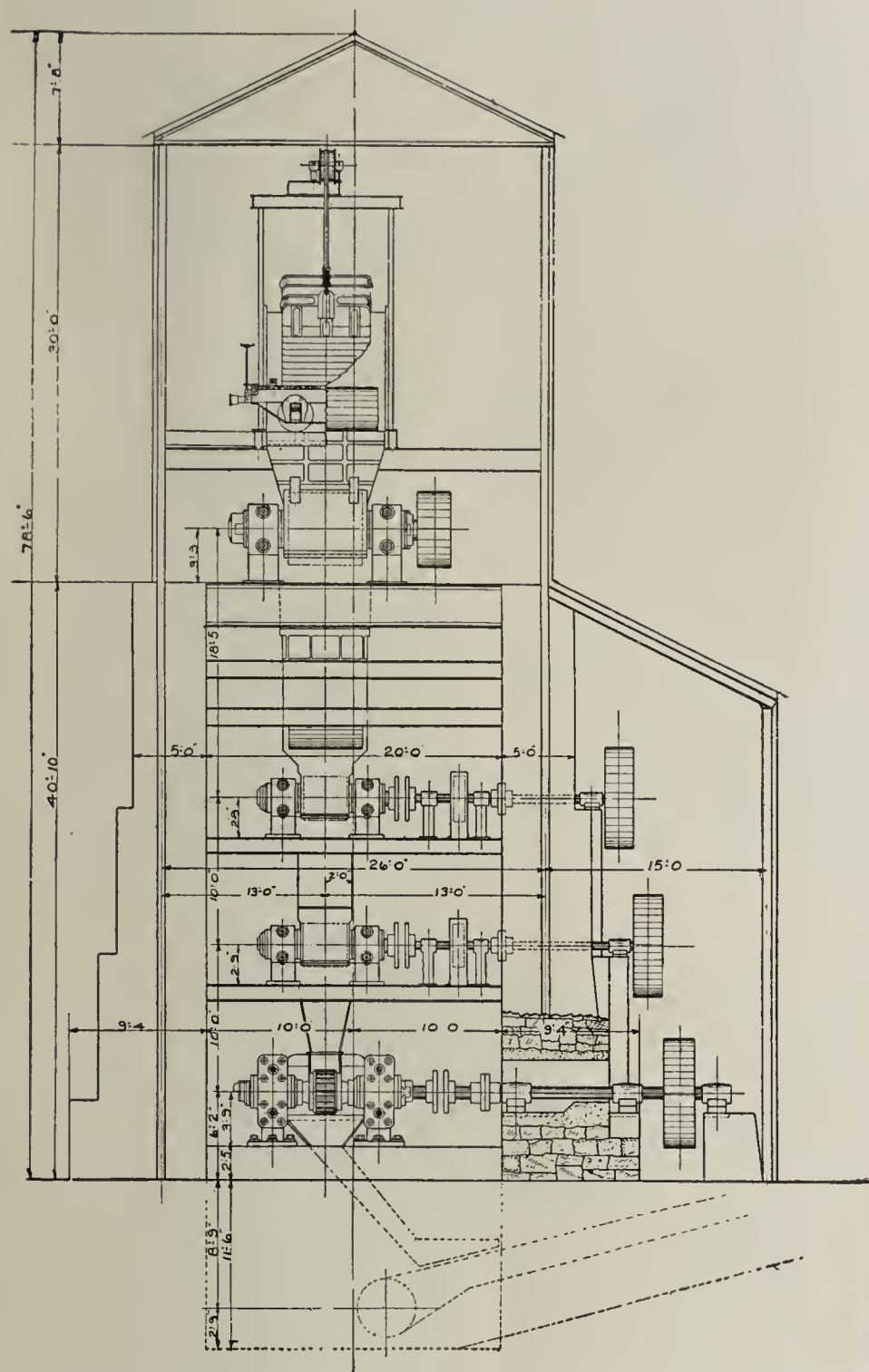


Fig. 4. End Elevation of the Crushing Plant of the Edison Portland Cement Company.

ers to a 500-volt circuit from the power plant. The usual blast is from 6 to 14 holes. In some blasts we have broken down 60,000 tons of stone at one time.

Ninety-five-ton steam shovels are used to load this stone into special steel skips for transportation to the crushing plant (fig. 6). In loading stones of this kind, it is necessary to handle them on the teeth of the steam shovel dipper and to roll them off into the skip. Steam shovel engineers become very adept in doing this, frequently loading a 5- or 8-ton stone in 20 seconds. The train of stone is then delivered to the foot of the incline at the crusher and is pulled up, three cars at a time, by an electric hoist. The skip is loose on the car and is dumped by another electric hoist, as shown in fig. 3. The entire contents of the car slides into the hopper over the giant rolls. Two distinct actions take place here: first, the sledging action due to the rapid blows (440 per minute) of the slugging knobs in striking the pieces of stone too large to be caught by the angle of grip of the rolls; second, the rolling action as the pieces are sledged off and caught between the rolls. It requires ordinarily

from 5 to 20 seconds to reduce to 6-in. sizes a stone weighing 6 or 8 tons.

The delivery of energy is so great in crushing stones of such sizes in so short a time that the rolls at once slow down in speed. The writer has made a number

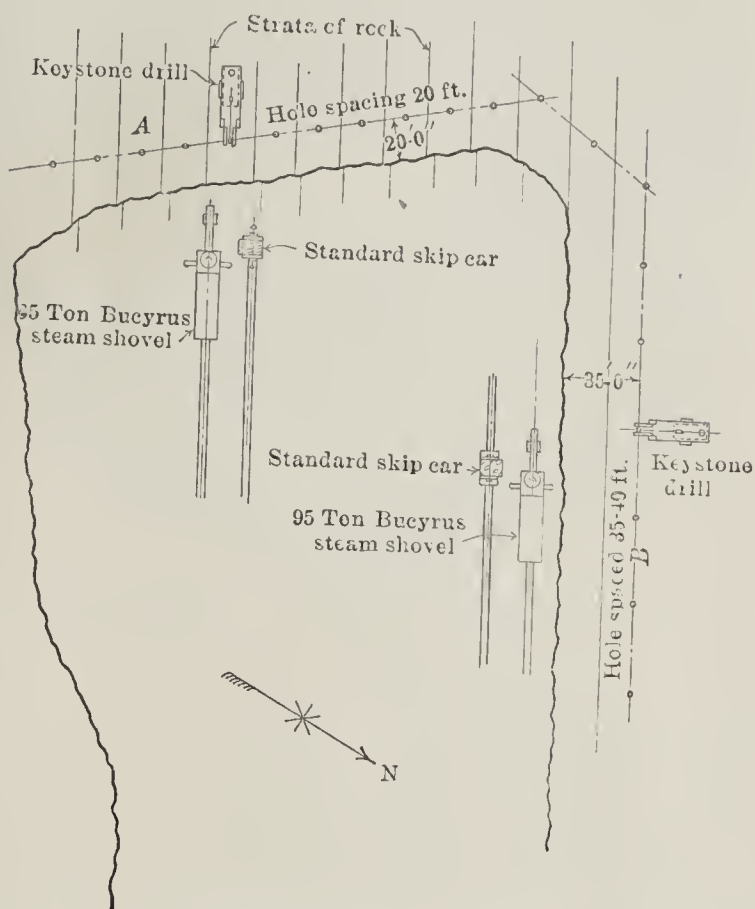


Fig. 5. Diagram of Cement Stone Quarry.

of tachometer tests (figs. 7 and 8) showing the action of these rolls while crushing a stone. To make these tests, two special Shaeffer and Budenberg recording tachometers constructed with their dials geared together, so they revolved in unison, were used. The recording arms of the tachometers were connected one to each roll-shaft and the dials were revolved while the rolls were crushing the rock. By this means the

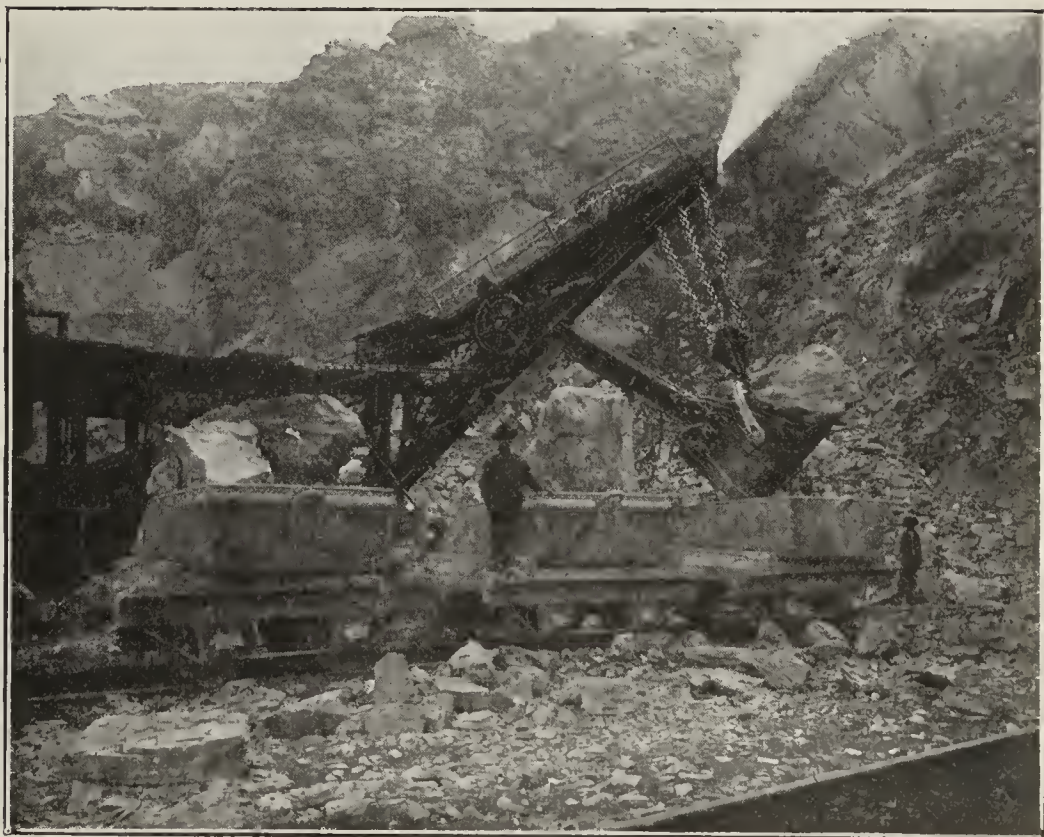


Fig. 6. Steam Shovel Loading Large Stones.

speed of one roll with relation to the other could be determined at any instant. The tachometer chart (fig. 7) shows that the slugging roll dropped in speed from 222 r.p.m. to 135 r.p.m. while crushing an 8-ton stone, and the regular roll (fig. 8) dropped from 220

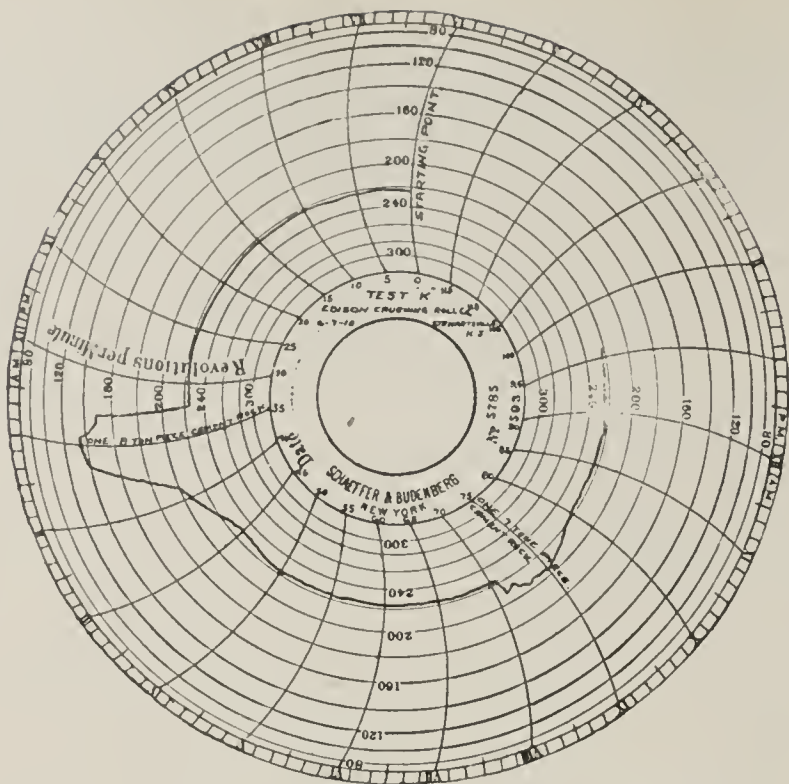


Fig. 7. Tachometer Chart for Slugger Roll.

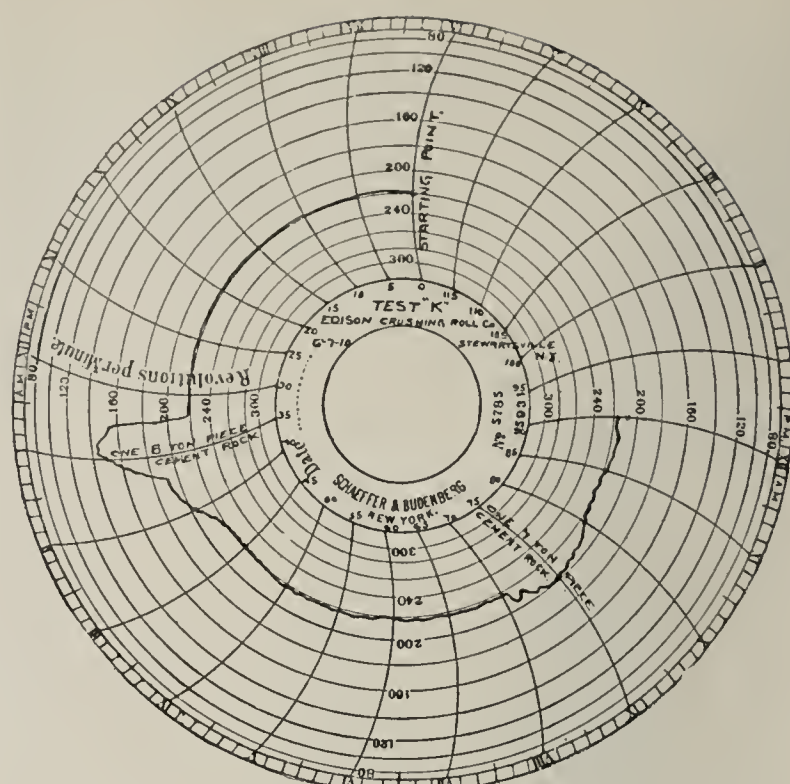


Fig. 8. Tachometer Chart for Regular Roll.

r.p.m. to 150 r.p.m., when they slowly regained speed until they reached normal.

While the second rock, almost as large as the first, was being crushed, the drop in speed was very much less. This may have been due to the fact that the stone was already partly shattered by dynamite, or to the manner in which it struck the roll. In the latter case the slugger roll ran constantly at a higher speed than the regular roll.

power curve, showing the horsepower delivered by the kinetic energy of each roll while crushing this stone, and also the horsepower absorbed by the rolls in returning to the original speed. In the last diagram on the sheet, by combining the above curves, the horsepower delivered by the kinetic energy of both rolls while crushing rock is shown, also that absorbed by both rolls while returning to their original speed. This shows that for approximately half a sec-

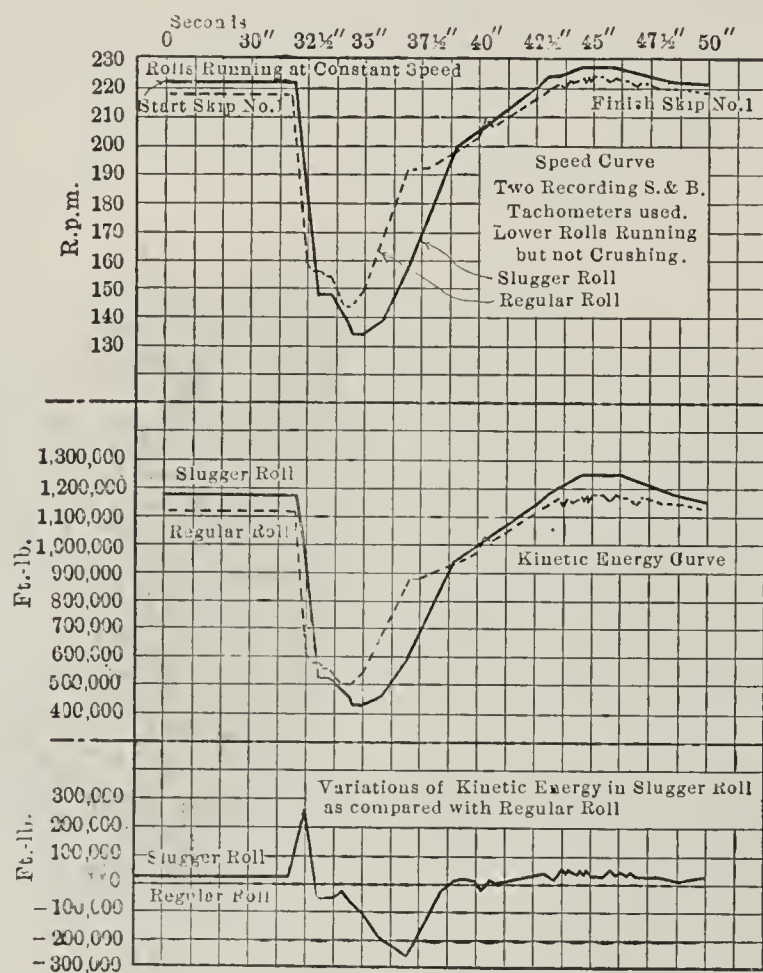
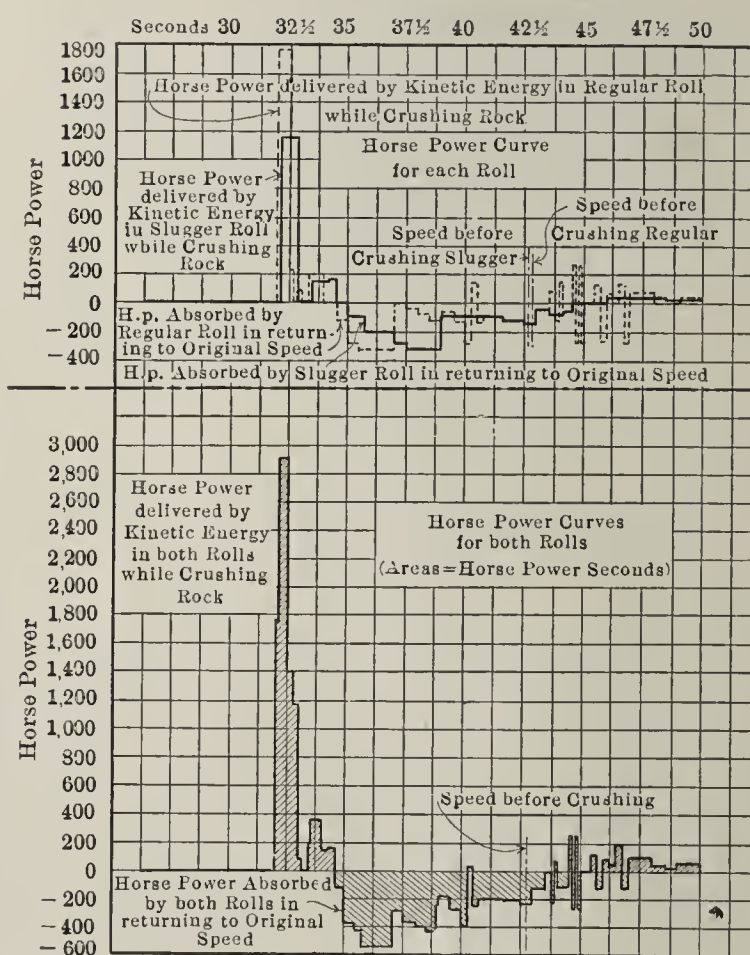


Fig. 9. Curves Plotted from Tachometer Charts.

Fig. 9 is a chart plotted from the dial records on the first stone crushed, showing the reduction in speed of the two rolls at any instant. From this chart was plotted the kinetic energy curve for each roll, the weight of each being about 25 tons. The variation in kinetic energy is also shown for the slugger roll as compared with the regular roll during this crushing operation. From these curves were plotted the horse-



and the two rolls delivered 2900 h.p. in kinetic energy, and the engine supplied about 600 h.p. additional, making a total of 3500 h.p. to crush the stone.

It can readily be seen how necessary it is to use the kinetic energy of the rolls when crushing rock, as the rated horsepower of the engine which drives these rolls and the three sets of smaller rolls is only 500 h.p. It also shows that practically all the stone was

crushed within 3 seconds, while it required about 10 seconds for the rolls to regain their original speed.

This reduction in the speed of the rolls occurs

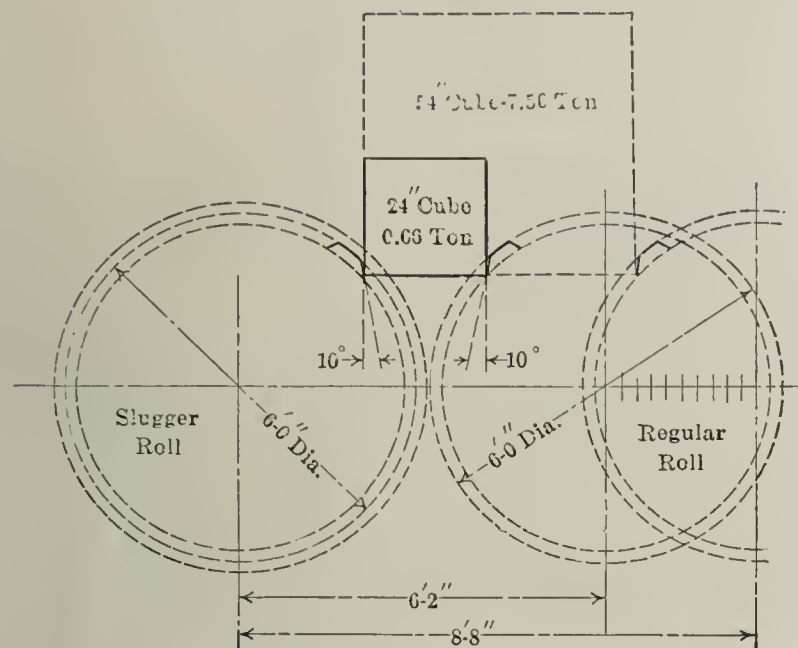


Fig. 10. Diagram of Crushing Rolls Showing Angle of Grip.

through the slipping of the drive belt over the pulleys. The engine slows down somewhat, but only a small amount compared to the slippage. As this slip-

TABLE 1 SIZES OF ROCK GRIPPED AND PASSED BY 6 FT. BY 7 FT. ROLLS FOR DIFFERENT SPACING OF ROLLS

Center to Center of Rolls	Bottom to Bottom of Corrugations	Size of Maximum Gripped	Maximum Cube Gripped	Maximum Cube Gripped	Maximum Stone Gripped at 165 Lb. per Cu. Ft.	Ratio of Cubes Gripped	Maximum Cube through Rolls	Maximum Cube through Rolls	Maximum Stone through Rolls at 165 Lb. per Cu. Ft.	Crushing Ratio
Ft. In.	In.	In.	Cu. In.	Cu. Ft.	Tons		Cu. In.	Cu. Ft.	Tons	
6 2	6	6	13824	8.00	0.66	1.00	75	0.043	0.0035	38.0
6 5	9	27	19682	11.40	0.94	1.42	262	0.15	0.012	16.3
6 8	12	30	27000	17.80	1.46	1.95	614	0.36	0.030	9.2
6 11	15	33	35937	20.80	1.72	2.60	1331	0.77	0.064	5.6
7 2	18	36	46656	27.00	2.22	3.35	2744	1.58	0.130	3.5
7 5	21	39	59319	34.20	2.82	4.28	4913	2.85	0.235	2.5
7 8	24	42	74088	42.75	3.53	5.35	8000	4.63	0.383	1.9
7 11	27	45	91125	52.50	4.33	6.60	12167	7.00	0.580	1.6
8 2	30	48	110592	64.00	5.28	8.00	17576	10.15	0.840	1.3
8 5	33	51	132651	76.50	6.31	9.60	24389	14.00	1.150	1.15
8 8	36	54	157464	91.00	7.50	11.30	32768	19.00	1.560	1.0

page occurs only for a short time it causes no serious trouble.

The sluggish roll does the most work in crushing

TABLE 2 MINUTES LOST ON ROLL CRUSHER

	Giant	1st 36 in.	2d 36 in.	3d 36 in.
Belt.....	2585	72	203	426
Choked.....	....	383	532	802
Large stone caught in hopper.....	955	....	....	....
Gears.....	....	1872	300	....
Starting.....	44	....	....	....
Bearings.....	168	282	....	20
Bolts.....	....	95	....	317
Plates.....	699	91	....	260
Shafts.....	337	....	238	....
Chain wobble.....	....	417	634	....
Sheared.....	....	1361	150	518
Miscellaneous.....	311	187	....	....
Total minutes lost.....	5099	4760	2057	2343
Total hours lost.....	85	79	34	39
Per cent ran.....	98½	98½	99½	99½

the stone and should show uniformly a greater reduction in speed than the regular roll. This however, is not the case, since the action of the stone in passing

between the rolls tends to gear the rolls together or to absorb energy from the faster roll and to deliver it to the slower roll.

The angle of grip of the rolls is not a definite angle and varies with the fracture of the stone and with the diameter and spacing of the rolls. Fig. 10 and Table 1 show these variations quite clearly.

The Edison Portland Cement Company has kept an accurate Time Lost account with each piece of ma-

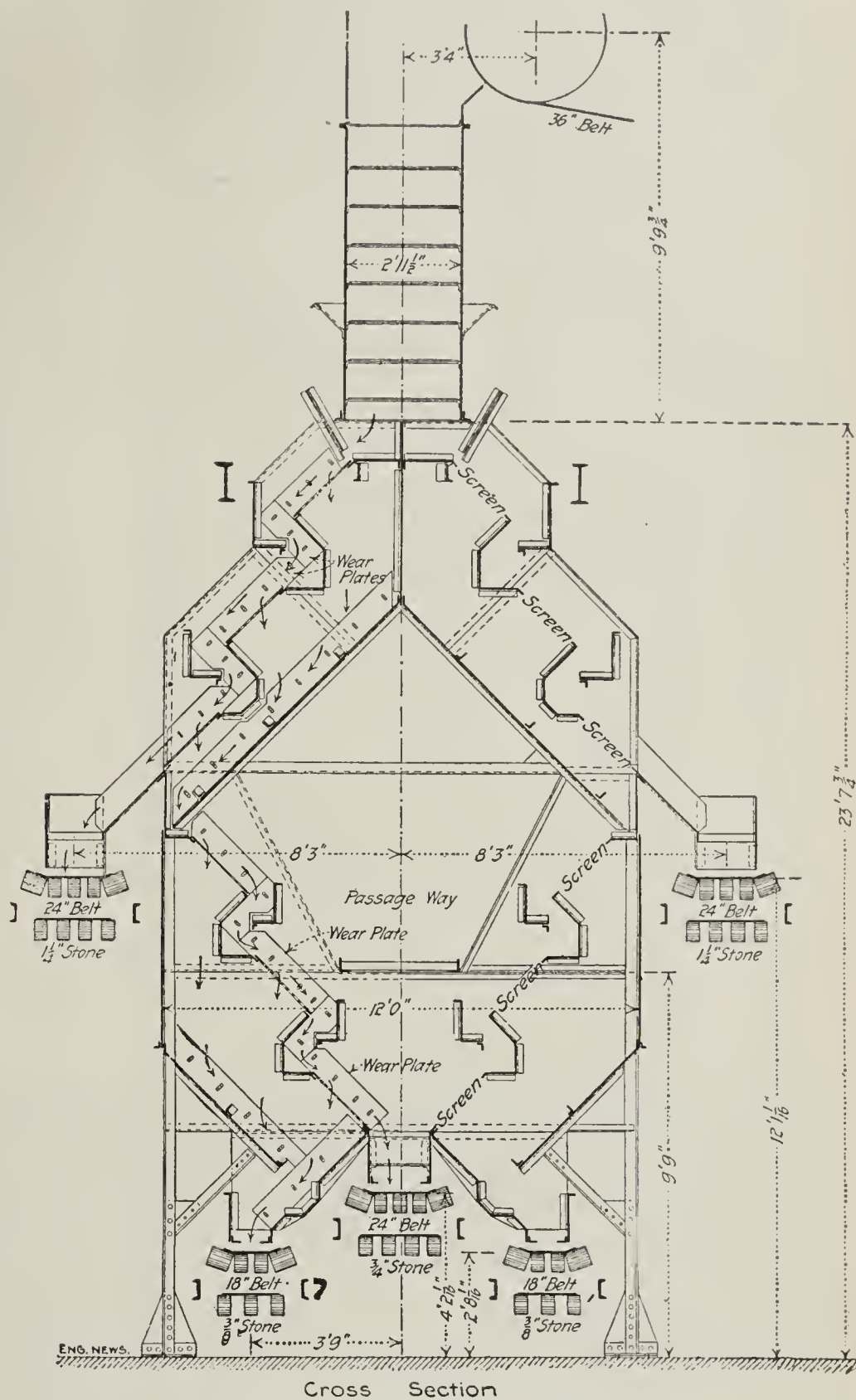


Fig. 11. Sectional View of Edison Sizing Screen.

chinery. An accurate statement of such stoppage for the years 1909 and 1910 are given in Table 2. The total loss of time is 237 hours, out of a possible running time of 4814 hours. The total delays due to the 4 rolls, therefore, was 4.9 per cent of the possible running time, and the average tons crushed per operating hour was 224.

The actual cost of all material bought or manufactured by our shops for repairs on the rolls is available, but the actual labor of making the repairs cannot be accurately determined, since it is included in the item of repairs to the crusher, car hoist, dryers, conveyors, etc. The charges for material are itemized as follows:

Roll plates	\$4,454.90
Bearings	92.04
Gears, shafts, etc.....	732.78
Plate and coupling bolts.....	240.88
Hopper plates	242.88
Belts	2,192.19
Miscellaneous	762.72
	\$8,718.39

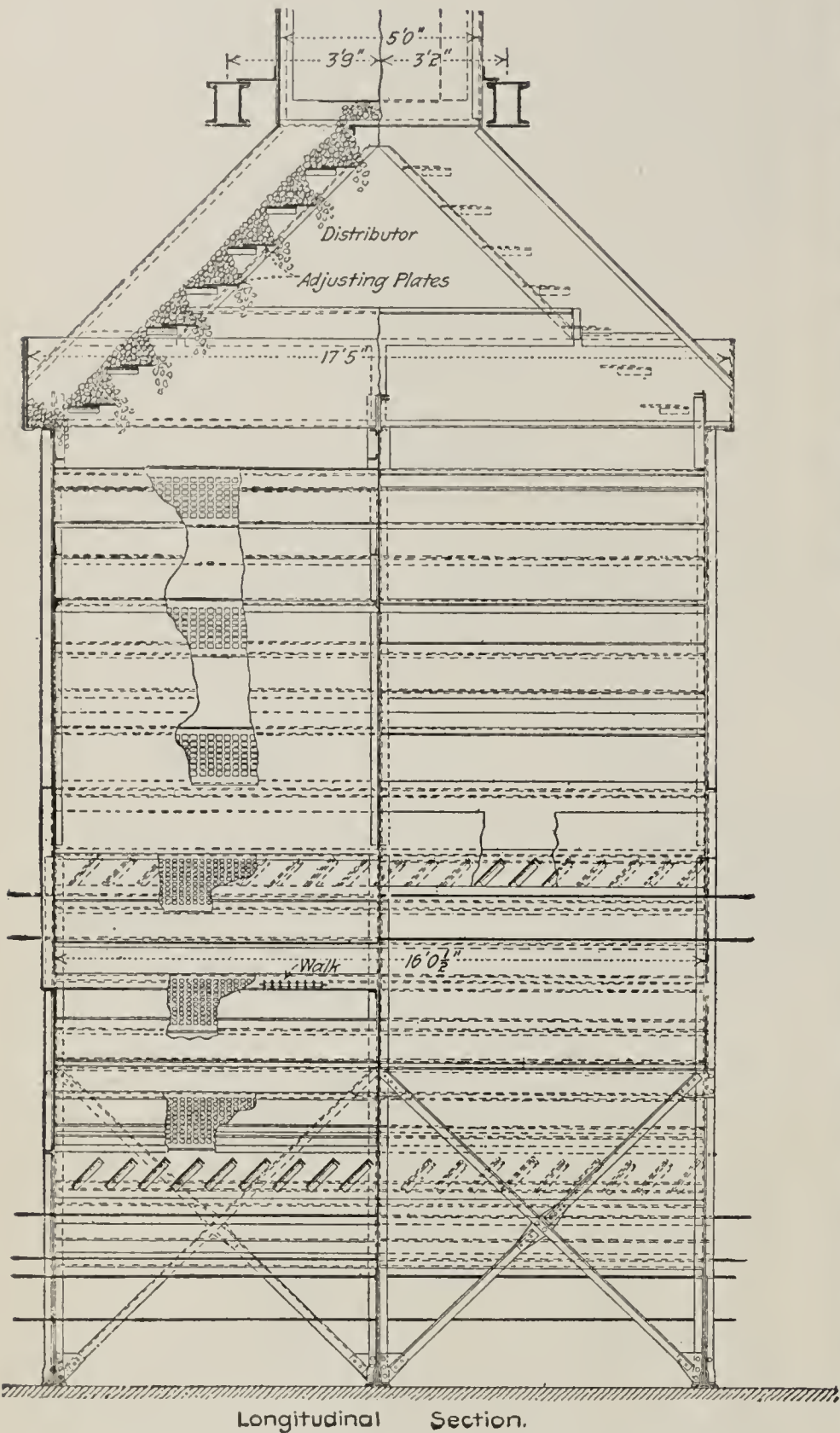


Fig. 12. End Elevation of Edison Sizing Screen.

During this time (two years) the plant reduced 1,024,409 tons of stone from 10-ton pieces, so that all would pass a $\frac{3}{4}$ -in. screen. This makes a plate cost per ton of \$0.0043; belt cost per ton of \$0.0021; general repairs per ton of \$0.0021 and total repairs per ton crushed of \$0.0085.

All of these rolls are driven by a prime mover inadequate to start them from a state of rest, and it is necessary to use levers or some similar device in starting.

The strains set up when a 15-ton stone drops 10 ft. or more to the rolls are enormous, as are also the crushing strains, but they are largely taken up inter-

nally because the rolls act as an anvil. Only a comparatively small part of the shock is transmitted to the bearings or driving power.

The wearing surface of all the rolls is made of chilled cast-iron plates. On the giant rolls the chill is about 2 in. deep, while on the smaller rolls it is from

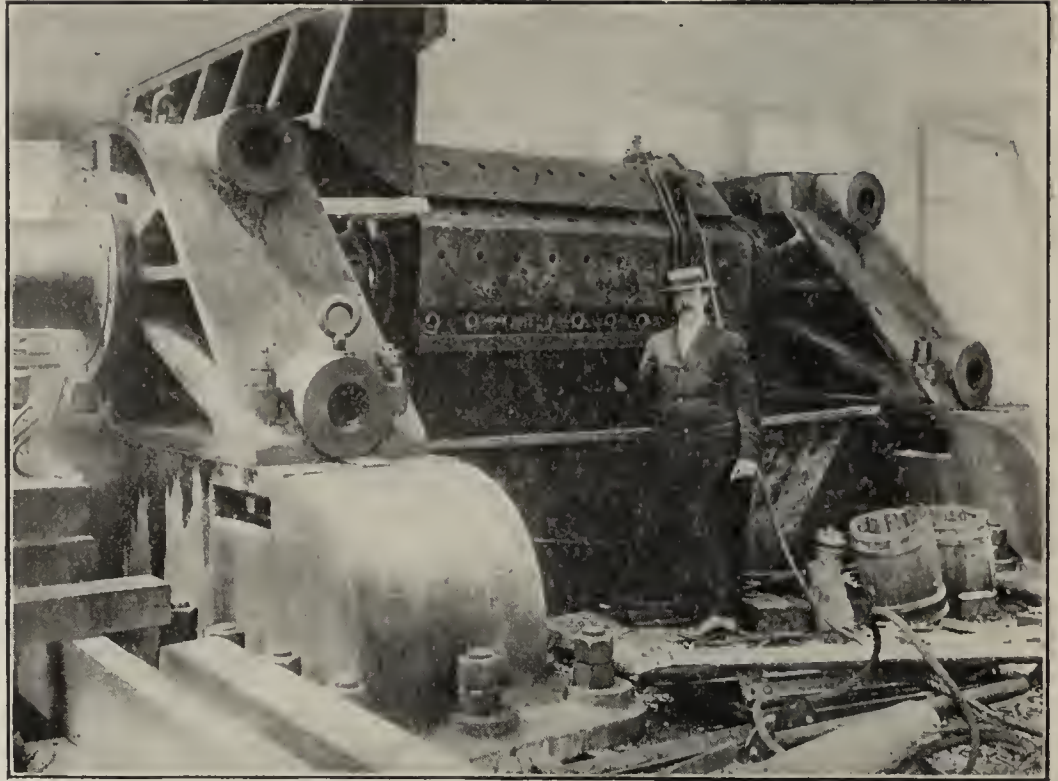


Fig. 13. Giant Rolls During Erection at the Plant of the U. S. Crushed Stone Co., Chicago.

$\frac{3}{4}$ in. to 1 in. deep. We have found that chilled iron, when properly made, wears much longer than manganese steel, and of course is much cheaper.

The capacity of the giant rolls is almost unlimited. In a recent test made on a pair of Edison rolls 6 ft. in diameter and 7 ft. long, 35 tons of stone were crushed in 32 seconds or at the rate of 4,000 tons per hr. This was done at one of the quarries of the Kelly Island

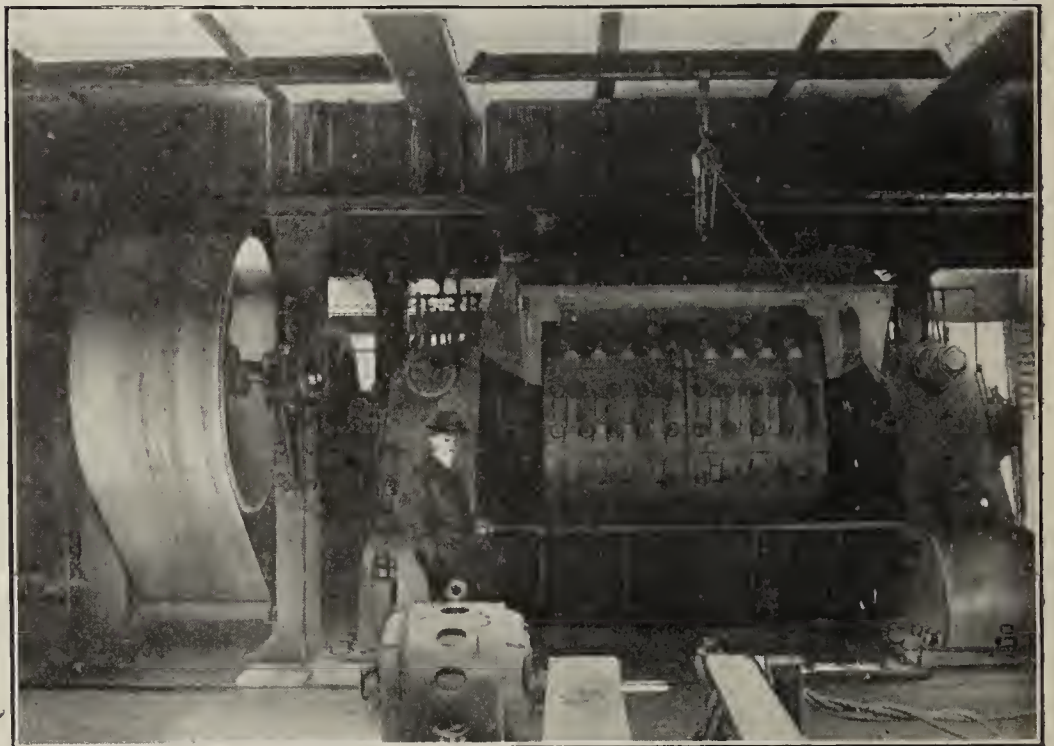


Fig. 14. Giant Rolls at Tomkins Cove. 6 feet by 7 feet.

Lime and Transport Co. on a dolomite "run of quarry" loaded by steam shovels, the pieces being 4 to 5 tons or less. Side-dump cars were used on this test and they were arranged to dump automatically into the hopper over the rolls as the train was pulled by. It is needless to say that at the end of the test the pan conveyor under the rolls was disabled and the rolls were running at a considerable reduction in speed.

The above figures may seem startling, but the theoretical capacity of the rolls is much greater when calculated on the same basis as that on which the capacity of smaller rolls is figured, and which the writer has frequently proved by actual tests to be correct.

The rolls are 6 ft. in diameter and 7 ft. long, are run at 185 r.p.m., and the average opening between the rolls is 9 in. This gives a surface speed to the

3487 X 7
rolls of 3487 ft. per min. or $\frac{\quad}{12} = 18,306$ cu. ft.

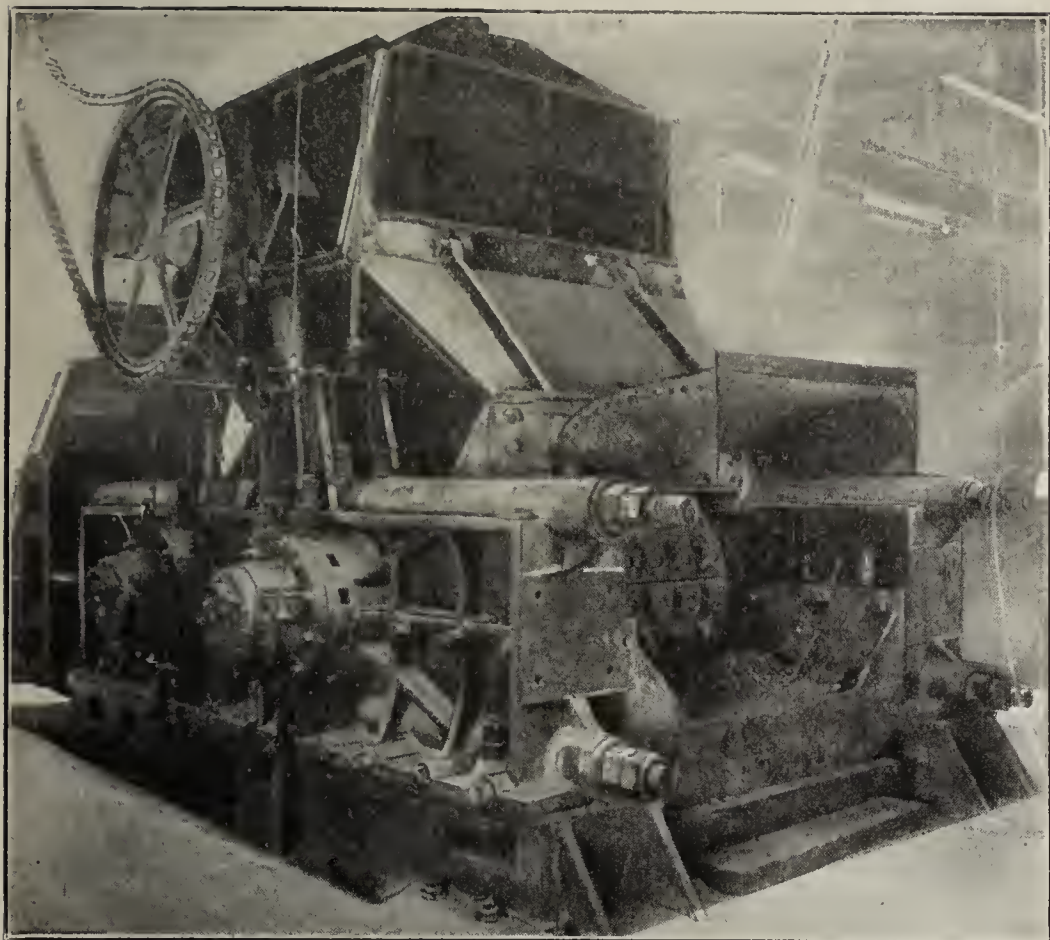


Fig. 15. Intermediate Rolls at Tomkins Cove. 4 ft. by 4 ft.

passed per minute. Assuming 20 cu. ft. per ton, this would be equivalent to 915 tons per min., or about 55,000 tons per hr.

The average horsepower required to drive these rolls while crushing 3000 or 4000 tons per day is quite small, ranging between 100 and 150 h.p., but the momentary peak loads are very much greater. One of the companies operating a pair of these rolls 6 ft. by 7 ft., motor driven, buy their power with certain peak load specifications. In order to reduce the peaks they have set a circuit breaker to cut off the current at about the normal load of the motor. After the stone is crushed the current is turned on the motor, and the roll again brought up to speed. It frequently happens that the current is cut off the motors by this method as many as 50 times a day.

Fig. 13 shows a set of 6 ft. by 7 ft. rolls being erected at the plant of the U. S. Crushed Stone Company, Chicago, Ill., and gives an idea of the heavy construction necessary to withstand the great shocks. This also shows the mandrels to which the plates are attached.

The crushing plant of the Tomkins Cove Stone Company, Tomkins Cove, N. Y.,¹ which was put in operation last fall, has, as far as the writer knows, the largest capacity of any plant in the world. Its extreme simplicity is one of the most striking features, and its design throughout is for a capacity of 1000 tons per hr. The stone, after being loaded with steam

shovels in the quarry, is dumped into a pair of 6 ft. by 7 ft. rolls, reducing it approximately to 8-in. sizes. Under these rolls there is a hopper having a capacity of about 30 tons. The stone is fed from this hopper by feed rolls to a set of 4 ft. by 4 ft. rolls, which run 250 r.p.m. This reduces the stone to about 3½-in. sizes when it goes directly to a set of 4 ft. by 3 ft. rolls and is reduced to about 1½ in. A large pan conveyor receives the stone and lifts it to an Edison stationary screen, which returns anything over 1½-in. sizes to the lower rolls for re-crushing. The product from this screen is carried by a 36-in. belt conveyor to the Edison sizing screens (figs. 11 and 12). Here it is divided into three sizes, known commercially as 1¼-in. stone, ¾-in. stone and ⅜-in. stone. It is carried by belt conveyors to concrete bins having a total capacity of 20,000 tons, from which it can be withdrawn and delivered by belt conveyors directly to barges or railroad cars.

The size of stone may be varied as desired by changing the openings between the rolls or the size of the openings on the screen plates.

Figs. 14, 15, 16 show the giant, intermediate and final rolls at the Tomkins Cove plant.

CLAY AND CEMENT TILE.

Of late there has been considerable discussion among dealers and manufacturers regarding the relative value of clay and cement tile. In a report on the subject, the state drainage commissioner of Minnesota says: "The action of the elements such as freezing, thawing, rain and heat will have a deteriorating effect on clay tile when exposed to the open air. Cement tile is now used quite extensively in drainage work. In some parts of the country cement tile seems to have been used for a number of years. I am of the opinion that cement concrete will enter to a much greater extent into the drainage work in the future than it has in the past. It is not effected by climatic conditions. Alternate freezing and thawing does not appear to deteriorate it after it has once been properly made and cured. There are no chemical properties in the soil that will appreciably injure cement tile."

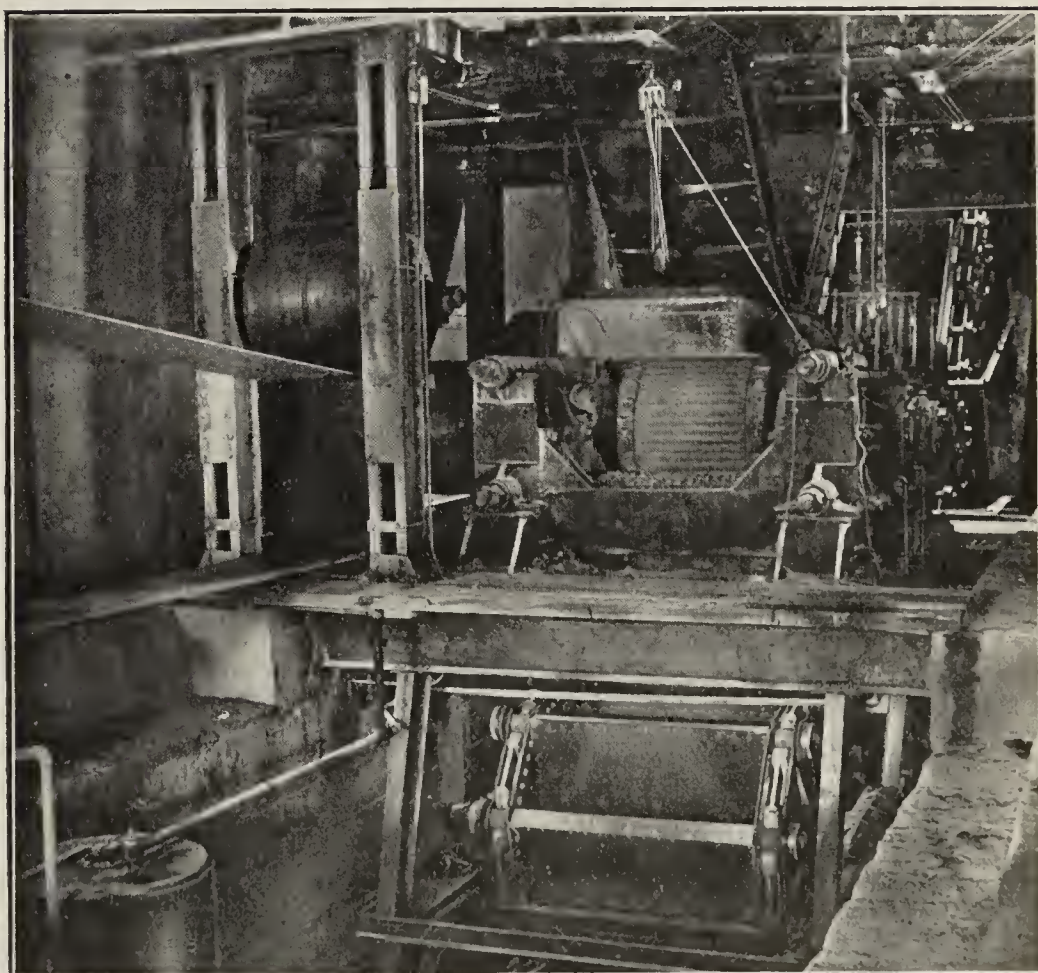


Fig. 16. Final Rolls at Tomkins Cove. 4 ft. by 3 ft.

¹This plant was more fully described and illustrated in Engineering News, January 12, 1911.

A Few Points for the Concrete Contractor

The placing of concrete is a matter of requiring considerable care. Forms should be perfectly clean and free from sawdust—a very hard material to get rid of. Care should be taken that no dirt falls into the concrete, a point that is often overlooked by workmen. At the north end of panels, beams, and girders placed north and south, and at the west end of panels, beams and girders placed east and west, there should be holes cut in the bottom forms, through which to brush the dirt and dust before placing the concrete. At the bottom of the column forms holes should be made through which to clean out sawdust and dirt of all kinds, and the holes should be on the north side.

The reason for mentioning north and east is that this is the practice of the writer. Any other location is as good; but there should be a system established and strictly adhered to. It is essential that the holes be filled before the concrete is poured, and men sent to fill the holes should find them with the fewest lost motions. When a certain location is established, then the holes will be quickly found. This is one of the little points making the difference between profit and loss in contracting work. For stopping holes in the bottom of forms pieces of tin are good. They can be made from old tin cans or obtained from a nearby tin shop, and short nails can be used to fasten them over the holes. For holes cut in upright forms a secure plug is made of a piece of wood, a little smaller than the hole, with a piece of tin fastened to it, and projecting over the edges. It is inserted in the hole with the tin on the inside, and a small wedge placed between the side of the plug and the edge of the hole will hold it in place until the concrete rises to that level, after which the pressure of the concrete will hold it.

Forms must be strong enough to retain wet concrete, which exerts a pressure equivalent to a fluid weighing 80 pounds per cubic foot, or it must be strong enough to withstand the pressure due to tamping in case a “dry” concrete is used. Years ago “dry” concrete was almost universally used. The cement, sand, and aggregate were dampened to such an extent that a handful, when squeezed, would retain its shape, but the hand would not be wet or stained and the lump would fall to pieces when shaken. It was like moist brown sugar. When concrete block machines were first introduced this quality of concrete was advocated because the forms could be removed within a short time. The claim was made that it was stronger than “wet” concrete. Some men still make that claim. When “dry” concrete was deposited in forms it was required that it be tamped until the moisture rose to the surface and the concrete quaked. It was really remarkable to see how little water was required to make a mushy-looking concrete after considerable tamping.

Wet concrete contains water in varying degrees. It ranges all the way from a concrete having slightly more water than what is termed “dry” concrete to a concrete so wet it runs like cream. In the days when “dry” concrete was common it was believed that an excess of water caused the materials to separate and the cement to settle to the bottom. The truth about the right amount of water is that the best and strongest concrete is that in which the consistency is that of a thick soup. Soup is of two kinds bouillon, which is thin and watery, and broth, which is thick. When

soupy concrete is mentioned it is of the broth and not of the bouillon variety of soup that one speaks.

Wet concrete is more economically placed than dry concrete, for it is mixed in a shorter time and requires no tamping. It settles readily into all corners and crevices, and thus presents a finer appearance on the surface. Better appearing work can be done with a flowing concrete. When concrete had to be thoroughly tamped it was hard to figure on the strength of forms, and bulging forms were common. With wet concrete the pressure is always uniform and can be calculated and the forms designed accordingly. When the concrete is reinforced dry concrete cannot be used, for it is absolutely essential that there be no displacement of the steel or disturbance of the bond between the steel and concrete. If dry concrete, with the necessary tamping, is used, the steel will generally be moved a little and the bond between the steel and the slowly-setting concrete will be disturbed. Wet concrete, which flows readily around the steel, is the only concrete to use with reinforcement. Thousands of tests have demonstrated that there is no tendency on the part of the cement to settle to the bottom and separate from the aggregate and sand if the concrete is of the proper consistency.

The writer commenced concrete work about twenty-five years ago, when dry concrete was the only kind permitted. He was discharged from one job twenty-three years ago because he permitted the foreman to use a wet, mushy concrete in filling certain pier forms. He received a few weeks ago an apology from the man who discharged him; but that does not recompense him for the loss he suffered at the time for what was termed his “ignorance and carelessness,” and which he thought was progressiveness. It was not uncommon in old-fashioned dry work to find the interior walls, when torn down, lumps of unset materials which had been rolled up into balls coated on the outside with cement, these balls having been formed during the mixing process. When a large amount of water is used such balls cannot form.

Dry concrete is not stronger than wet concrete. Hundreds, perhaps thousands, of experiments have conclusively proven this idea to be wrong. The results of these experiments have been published over the names of responsible and well-known authorities, so there is no reason to keep the old idea running. Dry concrete obtains a certain degree of strength in a shorter time than it takes wet concrete to obtain the same strength. This enables forms to be removed sooner with dry than with wet concrete. Wet concrete and dry concrete placed in the same day are of practically equal strength at the end of thirty days, but at the end of the first four or five days the dry concrete is the stronger. After thirty days the wet-mixed concrete gains rapidly in strength, as compared with the dry-mixed concrete, the latter picking up in strength if wet with a hose or otherwise drenched with water. Concrete requires water in order to set and harden properly, so the necessary water must be supplied during the mixing period. Three months after mixing the wet concrete is much stronger than the dry concrete, and it always retains this advantage; but as the years go by and the dry concrete has an opportunity to absorb moisture, and the wet concrete gradually loses excess moisture, the difference becomes small. For quick strength use as

little water as will make good concrete. For permanent strength and low cost in mixing and depositing, use wet concrete. Wet concrete is much more uniform in strength than dry concrete, and plenty of water is required to harden concrete. In summer a certain excess of water must be used to supply the loss caused by evaporation and the absorption of water by the sand and stone. In winter a much smaller amount of water should be used in order to obtain quick setting and thus avoid danger of freezing.

The foregoing matters have been touched upon several times; but they are very important. The forms should be tight in which concrete is deposited. The surface of the wood next the concrete should be smooth and the edges of the boards closely fitted. The forms should be thoroughly wet before the concrete is deposited in order to make the forms swell, and thus close the joints and prevent leaking. Another important reason for wetting the forms is to prevent them absorbing water from the concrete which it requires for setting and hardening. Use no oil on forms. Oil is nasty, and the atmosphere seems somehow to become filled with oily vapor after a few days of its use. It sometimes discolors the face of the concrete, and it is always difficult to properly treat surfaces which have come in contact with oiled forms. It is impossible to get rid of the thin oily coating, and it is impossible to make plaster stick to an oiled surface. The writer uses plain water or soap. Common soap can be melted in hot water or soap oil can be purchased from the nearest soap factory. It is applied with a brush and does not injure the surface of the concrete. It helps to make it waterproof and can be washed off with water when fresh, so that plaster can be applied.

Common whitewash is a fine material with which to coat forms. It would be difficult to find anything cheaper, and it is really very efficient in preventing concrete from adhering. If wet concrete is poured against dry forms large areas of surface will be pulled off with the forms, so that some coating is necessary. In the order of cheapness and merit the coatings stand about as follows: Water, whitewash, soap, oil. In the order of practicability they stand as follows: Whitewash, soap, oil, water, for water is apt to dry out during the filling of a high form, and more water cannot be added without thinning the concrete, already poured, and possibly injuring it. The writer prefers soap to all the coatings he has used.

The stopping of joints which open in forms is accomplished by the use of water to cause the wood to swell and partly by filling the joints with some material. The writer has found nothing equal to mud paste. A clay of some sort can generally be found in the vicinity of every concrete job, and it is an easy matter to mix it with the paste and fill all cracks. Sometimes a long time intervenes between the placing of the clay and the pouring of the concrete, so the clay dries up and falls out. Some contractors use thin oil with which to mix the paste instead of water, and this is generally satisfactory. The writer has used oil and has also used thin soap or very heavy soapy water. This is cheaper than oil, and much more readily mixed with the clay. Some fiber or hair mixed with mud paste makes it possible to use it in filling quite large cracks, although the use of fiber is not common. The writer has used it on several jobs with great satisfaction.

Concrete should be deposited in thin layers and be well tamped if dry, and well puddled with sticks and rods if wet, in order to fill all crevices and insure

that all aggregates are coated with cement mortar. When concrete is poured in at the end of the form and permitted to run down a slope, there is bound to be a separation of materials, the large pieces freeing themselves from the mortar and running ahead of it, the slow-going mortar generally setting before it gets an opportunity to cover the faster-moving aggregates, thus making porous places in the mass. When work is stopped all joints should be vertical.

When work is resumed the face of all joints should be washed thoroughly and then be coated with a neat cement wash. When the fresh concrete is poured it should be well spaded against the old face. Beveled strips placed in the edge of all work help to make keyed joints when work is resumed. To obtain a smooth face do not depend too much upon coats of plastering, but try and get it in the forms by using a perforated concrete spade or a potato fork to work in next the form and press back the large stones so that the mortar can work to the front. This is very good when making curbs and walls. For the top surface of curbs and walls, as well as for many floors and sidewalks, use a tamping device made on the principle of a wire potato masher to push down into the mass all large stones, and thus force the thin mortar to the surface. Smooth it off with a long board on edge, and then brush it over with a stiff broom instead of floating it. A lean mixture is generally used in the body of sidewalks and floors for the sake of economy. Sometimes it is cheaper to use a richer mixture all the way through and treat it as above described, thus saving the high finishing expense.

The reason that difficulty is experienced in making new work join to old is that not sufficient care is used in getting the old faces clean. Washing with water is not sufficient, and brushing is not sufficient. A wire brush is not always satisfactory, for it produces much dust, and this is not always washed off. The writer uses steam under high pressure on large jobs, for it will certainly clean off the concrete as nothing else will. If the job is not large enough, then use wire brushes and plenty of elbow grease, following with water applied through a hose. On jobs where steam cannot be had, then a solution of acid should be used to get the concrete perfectly clean. If reinforcing is used, do not use acid, but do the best work possible to make a good joint without it. When the top of a wall is setting, cement paste is forced up to the surface, and this sets and becomes dead, the product being known as "laitence." It is this laitence that makes the trouble. Sometimes men make a mixture of sand and cement one to three quite dry, and pour it over the top of a wall a few minutes before work stops, and puddle it well, so that as the cement paste rises it mixes with this dry material, and a semi-porous coating is formed on top, which contains no dirt. When starting work the next morning a thin paste of cement and water is placed over the top, and then on this a cement mortar one or two inches thick. The concrete follows quickly, and the result is generally a first-class joint.

In applying plaster to the face of concrete work, an attempt must be made to get a surface with a good suction, as painters term the property that makes a surface eat up paint. The surface should be first gone over with a wire brush, and this should be followed with a wash of weak acid, such as strong vinegar, sour beer, a weak solution of hydrochloric acid, etc. Then go over it several times with a wide brush dipped in water until the surface is damp, but not wet. Do not use a rich mixture for the plaster. Use one part of

cement to three parts of clean, coarse sand. Put the first coat on thin and scratch it. Apply with a hard pressure and let it set until strong enough to carry the next coat. Before applying the next coat, wet the first one, and then apply the second in the same way. Three coats will generally be sufficient. Avoid as much as possible the working of material more than merely enough to make it adhere. A lean mixture gives far better results than a rich mixture, and is not so liable to show hair cracks. Quick setting causes hair cracks, and a rich mixture sets quickly.—The Contract Record.

REINFORCED CONCRETE ROOFS.

According to an eminent authority on modern architecture, these roofs are made either with separate slabs molded at a factory and delivered to the building ready for placing, or by laying the concrete as a solid monolith on the roof supported during construction by temporary forms or stiffened expanded metal.

Molded reinforced concrete slabs are made in panels 2 to 3 inches thick, 2 to 3 feet wide, and 4 to 6 feet long, the length of slab being made to suit the distance between rafters. The ends of the slabs rest on the upper flanges of beam jack rafters, spaced 4 to 6 feet apart, and the horizontal edges parallel to the eaves should be tongued and grooved. The vertical joints over the jack rafters should be filled with asphaltic cement to better unite the separate blocks into a solid roof. Countersunk holes for bolts are molded in the concrete when the slabs are cast, and they are fastened to the roof by means of $1\frac{1}{2}$ x5-16-inch band iron clips and $\frac{1}{2}$ -inch bolts. When completed, the concrete may be covered with tar and gravel or some form of ready roofing. Slabs of this kind were used in 1906 on the National Guard Armory at New York City.

Solid monolithic slabs are made by spreading concrete either on flat expanded metal or wire mesh supports on temporary wood forms, or on some kind of self-supporting stiff expanded metal which needs no forms. There is a great variety of concrete systems, which differ chiefly in the style of reinforcement and the length of span. Many kinds of reinforcements include expanded metal, wire mesh, rods, etc., and the permissible length of slab depends upon the thickness. As it is desirable to have the loads a minimum, the slab thickness for ordinary roofs should not exceed 3 inches, and this thickness, properly reinforced, is strong enough for lengths up to 8 feet.

All concrete roofs must be waterproofed, and they may be covered with slate, tar and gravel, or tile. They are not injured by frost or cold weather. Nails may be driven into the cinder concrete within two weeks after the concrete is laid, and, like other embedded metal, the nails are preserved. Slabs may be laid directly on rafters without purlins when truss spacing does not exceed 10 feet, or on purlins between trusses for a greater truss spacing. The Coliseum and La Salle Street Station in Chicago have cinder concrete roofs.

Slabs of concrete 3 inches thick, reinforced with expanded metal, cost, in large areas, including concrete and metal only, without covering, 20 to 22 cents per square foot, while smaller areas cost 30 cents per square foot.

The American System uses 3-inch slabs weighing 25 pounds per square foot, reinforced with steel rods, for lengths up to 8 feet, and 5-inch slabs weighing 39 pounds per square foot, with $1\frac{1}{2}$ -inch tees, for lengths up to 16 feet.

STEEL SIDEWALK FORMS.

Probably no invention of recent years has done more to revolutionize any industry than has the Ubbink System of steel forms manufactured by the Ubbink Co., Port Washington, Wis., for the construction of concrete sidewalks and crossings. They are now used by hundreds of the leading contractors throughout the country, who are highly pleased with them, as they find that these forms save them over two cents per square foot on all their work, and enable them to lay 25% more walk per day with the same gang. It will therefore be of interest to contractors to learn that the Ubbink System of steel forms has now been extended to the construction of concrete curb and combined curb gutter. Although these forms have been on the market but a short time, they have already met with a large sale and have given great satisfaction. In fact, many contractors, who were willing to continue the old-fashioned method of sidewalk construction with two-by-fours and stakes, took to the new invention at once.

They cut out the lumber bill.

They save ten cents per running foot in labor.

They are accurate and uniform and require no measuring.

The surface can be struck off in a single operation.

The forms are interchangeable so that the same outfit, with additional templates, will make either curb or combined curb and gutter. If desired, templates may be had for use in connection with the rails of the Ubbink steel sidewalk forms.

They are light to handle and indestructible.

A few years ago the only curbing to be seen was stone curbing. Now this is rapidly being replaced by neat concrete curbing to a considerable extent, but even more by combined curb and gutter. Straight curb is all right and in many cities will continue to be laid.

COLORING CONCRETE.

In the latest report of the committee of the National Association of Cement Users, on Exterior Treatment of Concrete Surfaces, it was recommended that only certain mineral pigments, given in the following list, should be used for obtaining tinted mortars for concrete or stucco surfaces:

Grey,	Slate,
Red,	Bright red,
Brown,	Yellow,
Blue,	Green,
Violet,	Lampblack, Manganese Dioxide.
Red iron oxide.	English red oxide.
Brown roasted iron oxide, brown ochre.	
Ochre.	
Ultramarine.	
Chromium oxide, ultramarine green.	
Violet oxide of iron.	

The amount which can be safely used is small, owing to the danger of impairing the strength of the resulting mortar. Five per cent by weight to that of the cement should be the limit, beyond which the impairment of strength is too great to justify a larger amount. Even this amount of certain colors which differ little from that of cement—such as yellows and reds—does not produce a marked change from that of the neat cement. Lampblack is the principal ingredient used for darkening. For lightening the color somewhat, lime is the best material to use. Coloring matters can be used in either a dry form or as a paste. It will generally be found most convenient for mixing, to use the dry form, thoroughly mixing it with dry mortar before the addition of any water.

Water Power and the Great Water-Falls of the World In Their Relation to Industry and Conservation

Edison said that it was cheaper to transform the water power of the mountains into electricity and then use it to pump water for irrigation in the valleys than it was to impound the water and transmit it through canals for the same purposes. Apparently that is the opinion of the great power companies of California for only last week the Great Western Power Company published the statement that the great dam on the North Fork of the Feather river above Oroville would be completed by 1913, and with the additional plants then constructed the company would have 500,000 horse power at its disposal, the largest plant in the world. This is a great undertaking and speaks much for the potential resources of California when one realizes that it is a subsidiary stream that is being utilized for this purpose and only a fractional part of the water power of the State. The company proposes to expend twenty millions of dollars in this construction. This is an enormous sum, and no doubt profits have been figured out for the capital to be invested. This means power to be transformed into light, into railway motive power, into pumping stations for irrigating purposes, and the hundred and one uses of modern industry. The construction of the reservoirs alone is estimated to cost \$2,000,000. It will be the largest in the world. The water it will impound will cover from 25,000 to 30,000 acres, and will supply the water for its numerous concrete canals and tunnels that will connect with the power stations.

Considering this as an illustration of the power to be developed from a single subsidiary stream of the State, the question naturally arises how far the great rivers of the world may and will be utilized in developing power for future generations. In this regard there is an interesting article reviewed in the current issue of the *Scientific American* from Dr. Richard Herring, on the great waterfalls of the world in their relation to industry and conservation. It was originally published in *Ueber Land und Meer* and is herewith reproduced for the benefit of our readers:

The waterfalls of the earth have become the subject of a conflict which is yearly increasing in violence. The lovers of nature wish to preserve the waterfalls in their original condition as far as possible for all time, while the engineers and industrial promoters seek to exploit them as sources of cheap power for electro-technical purposes. The accomplishment of this object involves the total destruction or serious injury of the waterfalls, regarded as picturesque additions to the landscapes. It is only within recent years that waterfalls have been considered from the commercial point of view, but since it has been recognized that the energy of flowing water in very many cases furnishes a cheap and almost inexhaustible substitute for coal, which is yearly becoming more costly and more largely consumed, the great waterfalls which, as impediments to internal navigation, have hitherto been worthless from the viewpoint of social economy, have suddenly become objects of very great value. The falling water drives the turbines of electrical power stations, producing electric light and power which, in many cases, is transmitted over hundreds and even thousands of miles. The war over the waterfalls which is now being waged by the friends of nature and the promoters of industry is likely soon to increase greatly in bitterness, for many celebrated falls have already been destroyed, or have at

least suffered serious aesthetic injury from the establishment of power stations. The famous Falls of the Rhine, at Schaffhausen, are at present the subject of heated controversy. Several power stations already stand on their banks and sap their life blood. The Swiss government, however, takes care to preserve a sufficiently large volume of water to maintain the character of the falls as a notable spectacle and an attraction for tourists. A still more bitter strife has been engendered in America by the question of the preservation or destruction of the Falls of Niagara. These famous falls have already narrowly escaped entire absorption in the pipes of power stations and very energetic action on the part of the lawmakers, both in the United States and in Canada, has been required to keep intact from industrial invasion and preserve, in its original beauty, at least a remnant of this great wonder of the world.

Another North American waterfall which, as the highest fall in the whole world, especially deserves preservation as a natural monument, is apparently assured against destruction for all time. This is the Yosemite Fall in California, which makes a descent of 2,600 feet in three successive stages. As the whole Yosemite Valley, which was not discovered until 1851, was made a National park in 1864, the Falls of the Yosemite are under governmental protection and their pristine beauty can never be marred by the establishment of any power station.

There is a popular but erroneous impression that the Falls of Niagara are the greatest in the world, and even those more enlightened persons who know that the Victoria Falls of the Zambesi River in Africa are twice as broad and more than twice as high as those of Niagara, almost invariably assign to Niagara the second rank among the great waterfalls of the earth. Even this is an error, for South America possesses a waterfall which exceeds Niagara both in width and in height and is actually the second largest waterfall in the world. This little known waterfall is that of the Iguassu River, a tributary of the Parana, and like Niagara it is situated at the boundary of two States, each of which owns half of it. The total water power of the Iguassu Fall, which is 213 feet high and nearly two miles wide, is estimated at about fourteen million horse power. This is approximately equal to the aggregate water power of all Scandinavia, which is so rich in waterfalls, or about ten times the total water power of Germany. The temptation to exploit this great, inexhaustible, never-freezing stream as a source of power for industrial purposes may easily be imagined. At present such exploitation is quite impossible, as the Iguassu Fall is too far from the beaten tracks of commerce to make it profitable to establish any electrical power station, but it will probably not be long before these falls will be threatened with the fate of Niagara. This undesirable possibility has been foreseen by the interested States, Brazil and Argentina, which have already begun negotiations designed to protect the falls.

The largest of the earth's waterfalls, the Victoria Falls of the Zambesi River, in Rhodesia, which are 386 feet high and more than a mile wide, and which were discovered by Livingstone in 1855, have also become the subject of a compromise between the conflicting demands of the lovers of nature and the promoters of industry. The water power of these falls is estimated to be fully thirty-five million horse power,

two and one-half times that of the Iguassu and five times that of Niagara. By way of comparison, it should be noted that the aggregate water power of the whole of Europe cannot greatly exceed thirty-five million horse power. It is certainly possible to derive a few million horse power from this great fall without appreciably detracting from its majestic beauty. The demands which are made at present are still more modest. The Victoria Falls Power Company ask for only 150,000 horse power, less than 1,200 part of the whole, and the plans for the future development of the station involve no danger of the annihilation of the falls. The British government and the colonists know very well that the Victoria Falls, which since 1905 have been easily reached by the Cape-to-Cairo Railway, which crosses the Zambesi immediately in front of the principal fall, will certainly bring as much money into the country by attracting tourists as by producing electrical power.

There is no other waterfall in the world which is at all comparable in greatness with the Zambesi, Iguassu, or the Niagara. Asia, notwithstanding its colossal mountain ranges, is comparatively poor in large waterfalls which are found most abundantly in Africa and North America. The largest African streams, especially, are interrupted by many falls of considerable height. The Congo has several high falls which, owing to the great volume of the river (about sixteen times that of the Nile), may be counted among the most important sources of water power on earth. The Stanley Falls, in the middle reach of the river, consists of seven successive falls, of a total height of 164 feet and a width of nearly 4,000 feet, and offer an exceedingly rich source of power which probably will soon be exploited. Still more important is the total water power which the Congo develops in the non-navigable section extending from its mouth to Stanley Pool. Here the river, confined in a channel only a few hundred yards wide, and with a depth of water of nearly 300 feet, flows with a velocity of 48 feet per second so that at every point of the stream 25,000 to 30,000 cubic meters, or about a million cubic feet, of water are hurled along with irresistible force, while thirty-two rapids and waterfalls lower the level of the stream by 820 feet in a stretch of 170 miles.

The lower Nile in Egypt possesses a series of rapids, the celebrated Cataracts of the Nile, but no waterfall in the strict sense of the word. True waterfalls occur on the upper Nile, the most beautiful of them at the point where the stream issues from Lake Victoria Nyanza. This Ripon fall is only a few yards in height, but the volume of water is so great that it presents a magnificent spectacle.

Comparatively few persons know which is the highest waterfall in Europe. The most voluminous of European waterfalls, strictly so called, are the Rhine Falls at Schaffhausen, but the highest are the Rjukan Falls of the Maan-Elf River in the Norwegian province of Telemarken. The principal fall is 800 feet high and the total height of the two chief falls with the intervening rapids amounts to 1,837 feet, while the average flow of water is 50 cubic meters, or 1,760 cubic feet per second. The largest water power station yet projected is here being developed by the Badische Anlin und Sodafabrik, in conjunction with other firms, for the fixation of atmospheric nitrogen. The Rjukan Falls, with their total energy of 250,000 horse power, are already things of the past, for they have been irrevocably perverted to industrial uses. A similar fate threatens other small Norwegian falls, but Norway is so rich in waterfalls that it can well spare a few. In Sweden, likewise, the Falls of Trollhatta, the most celebrated of all Scandinavian waterfalls, have been almost entirely annihilated as objects of natural

beauty. Nearly all of their water is now employed for the production of electricity. The government itself has recently established here a power station with a capacity of 40,000 horse power. This, now the largest water power station in Europe, will soon be surpassed, however, by the station at Rjukan in Norway and by a still larger station in the north of Sweden, which will serve for the operation of the Lofoden Railway.

The Porjus Fall, at which this last mentioned station will be placed, is only one fall, or rather rapid, of a long series formed by the Lule-Elf, near its source in the lake region of Lapland.

The largest and most beautiful of these falls is the celebrated Harsprang, which form the subject of many legends. The Porjus power station is expected to reach completion in 1914 and to develop soon afterward about 80,000 horse power, yet the wild beauty of the Porjus Fall will be little affected, as it is estimated that its total water power in summer, after its sources of supply have been regulated, will be about 300,000 horse power. In the Porjus Rapid the river descends 164 feet in about 2 miles. The Harsprang is also half waterfall and half rapid and accomplishes a descent of 244 feet in $1\frac{1}{4}$ miles. The Harsprang would therefore yield more power than the Porjus, but it is to remain untouched for the present, and it is to be hoped that it will be forever preserved as a natural monument. Sweden, with its great wealth in water power, can well afford such a luxury. Even little Finland is endeavoring to preserve natural beauty and has decided to keep her greatest waterfall in its original condition as a natural monument, and to allow no large power station to be erected on its banks. This fall is the celebrated Imatra Fall on the Wuoxen River. The total descent is only 66 feet in two miles, but the volume is very great and the depth considerable, while the width of the stream contracts from 570 to 150 feet in the course of the falls.—Building and Industrial News.

CATALOGUE OF THE JEFFREY MFG. CO.

The latest catalogue of the Jeffrey Mfg. Co., of Columbus, O., must be called the most complete and up-to-date power and transmission catalogue in existence. That is to say, there are more subjects listed and there is more technical and real information in this book than in any similar publication.

The catalogue describes power and transmission in a way that will make this book exceedingly valuable to the engineer in charge of an industrial plant, a mine, mill or large factory where this class of machinery is used.

Besides listing dimensions and sizes of every part in this line, it contains descriptive matter on the horse powers of steel shafting, standard methods of key seating, sizes and dimensions of couplings, hangers, pillow blocks, counter shafts, belt tighteners, clutches and quills.

A feature is made of the Jeffrey improved split iron pulley, which may be readily clamped on the shaft without disturbing any other equipment, or may easily be removed from the shaft when necessary.

A complete line of wood split pulleys and a very complete description and information on rope driving are shown.

Another important chapter of this book is the complete listing of the Jeffrey gears, including spur, bevel, miter, angle reduction and angle miter.

There are quite a number of details in the rear part of the book, including horse power of belts, method of calculating bending and torsional moments for shafts, which are invaluable to the engineering fraternity.

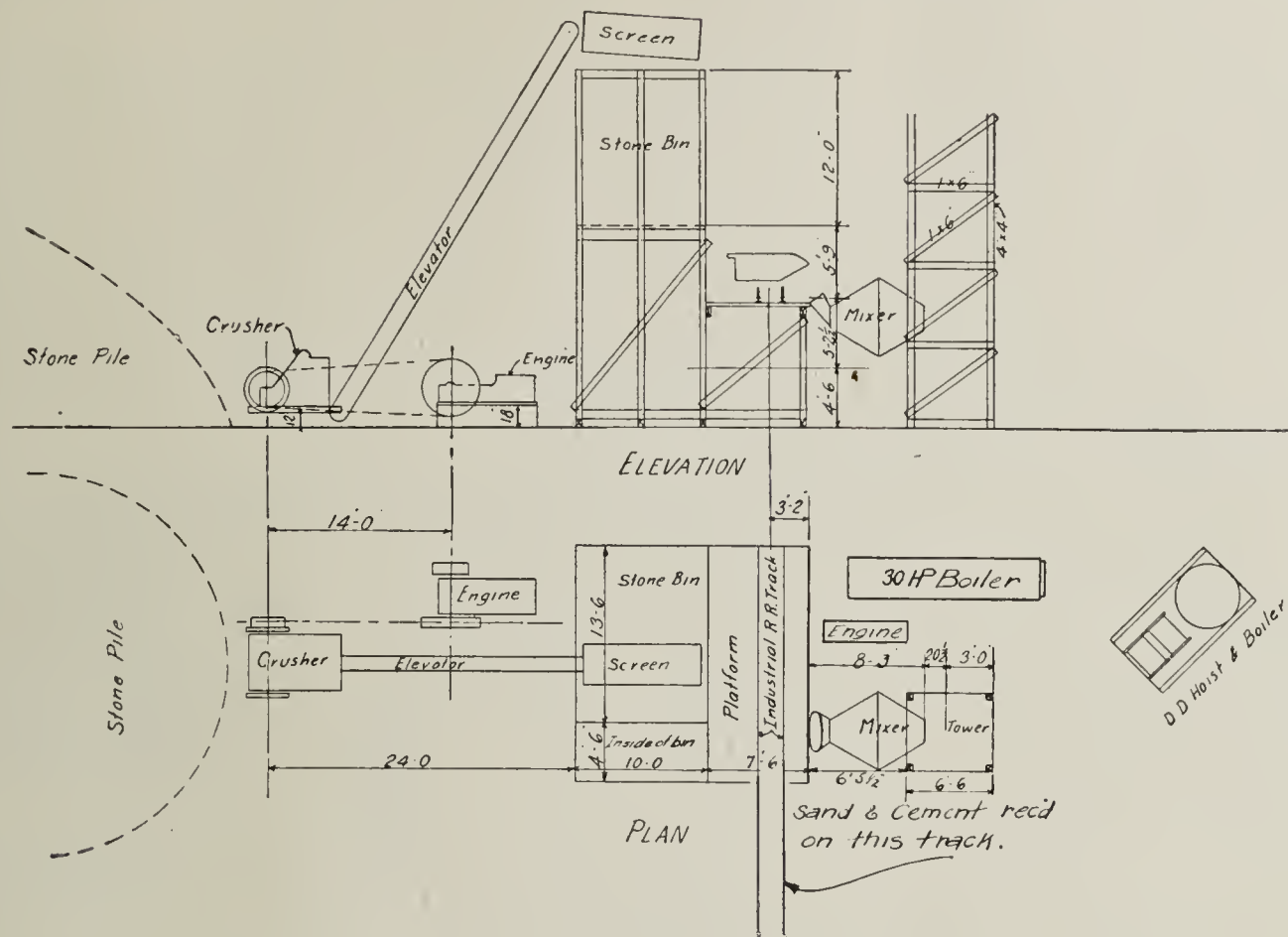
A COMPACT MIXING PLANT ON A BIG JOB.

Sanford E. Thompson, the well-known authority on concrete, says that "the design of plant for handling the raw materials for concrete usually has more to do with economy in mixing than the particular type of any mixing machine." There is no question but that this is a sound statement and contractors know there is no hard and fast rule for plant layouts and that the best way is to study what has been done on other jobs and get suggestions from the same. As each layout depends on multifarious things such as the character of the ground, the class of work, the money in the job, the time allowed for completion and other special conditions, it is worth while to note from time to time how contractors have solved this problem on various jobs.

As an example of a compact and economical concrete plant layout might be cited the one erected by the Aberthaw Construction Co. in building eight new reinforced concrete flumes for the Penobscot Chem-

CONCRETE BLOCK CONSTRUCTION.

I think it about time that the true friends of the cement block resent the wornout, nonsensical idea, that the use of rock face patterns for cement blocks should be condemned, says Frank Zagelmeyer, Bay City, Mich. Man is by nature an imitator. It is by imitation that he finally learns to excel, and the better he can imitate the more successful he is. The sculptor takes a stone and makes an imitation man or beast; the painter takes a piece of canvas and some paint and imitates nature. In fact the basic principle of all art is founded on scientific imitation, and simply because some poor sculptor or some unskillful painter makes a bad imitation of his subject, the loyal supporters of the somewhat uncertain science of art, do not blame art itself, but the artist. This is, as it should be in concrete. Just because some block-makers put poor rock face designs on their blocks, is no reasons for blaming the design, but the maker, and all true friends of the block industry, instead of con-



ical Fibre Co. at Great Works, Maine. Each of these flumes is 58 feet long, 14 feet high and 16½ feet wide and were designed by Hardy S. Ferguson, consulting engineer, New York.

Of necessity, this mixing plant is located out in the river over the tail races which were constructed last year. The sand and cement are brought from the railroad 1,200 feet distant by side dumping cars running on an industrial track that extends above and back of the mixer. The crushed stone is raised by an elevator to the bins as shown and by one or two chutes is fed into an independent side dumping car on the same industrial track as the sand and cement cars.

The cement and sand are received, proportioned, and dumped into the mixer and then follows the stone from its car. Thus there are two operations for each batch. The mixed concrete is finally raised in the tower by a double drum hoist and deposited into the carts that deliver it to the point under construction. The concrete is proportioned generally 1:2:5.

The closeness of quarters is appreciated when it is noted that the extreme width of the mixing plant is 18 feet and the length over all only 54 feet. It is such careful planning as this that brings economical results.

demning the use of the rock face design, should use their efforts in encouraging better rock faces.

As a manufacturer of cement blocks, as well as block molds, I want to state that my experience leads me to believe that, if left to their own judgment, at least ninety per cent of the purchasers of cement blocks will choose the rock face design, if a large variety of well-made patterns can be had. The trouble in the past has been lack of imitation rather than imitation. One pattern used throughout a job, and that pattern designed by a carpenter, is not imitation of rock face stone, and it is this lack of imitation that has caused what little real objection there is to the rock face design, from the users of cement blocks. The users are the ones who pay for them, and consequently are the ones who count with the manufacturer.

The idea that the rock face design should not be used, simply because it is an imitation, probably started with some architect who thought he possessed the artistic temperament, and this idea has been copied by other architects all down the line. Architecture is just as much subject to imitation as any other art; in fact, if the architect was to eliminate all imitations from his craft, what would be left of it? Did you ever stop to think how few original characters

there are; that is, architects who have original ideas? Once in a while one stumbles upon an original idea, then all the rest of them imitate. Although quick to copy from each other, they are slow to take an idea, no matter how good, from anyone else. This is why they have been slow to see the possibilities of concrete. The architect has certainly been no friend to the cement block industry. I am not speaking of individual cases. Of course there are a few men in this profession, as there naturally must be in all classes, who have broad minds and quick conceptions, who saw far enough into the future to see the advantages of the cement block as a building material; but as a class, the architects (next to the careless block-maker) have been the industry's worst enemy. The tremendous popularity of the rock face design for cement blocks, in spite of the inferior quality of a large percentage of the same, as well as of the blocks themselves, but indicates the demand for a first class article, and it is the duty of the supporters of this industry to endeavor to supply this demand by encouraging the improved quality of the article demanded instead of taking it away from them entirely. There is just as much change for improvement in the average cement block itself as there is in the rock face design of the same. That they can both be brought to a stage of perfection that no one can criticise I have proven, and at the same time greatly reducing the cost. I don't wish to be understood to mean that the only future the cement block has is through the use of rock face designs. There are several other applications, some of them capable of being made very beautiful, but the rock face has from the start and probably always will be the favorite design of face for cement blocks.

FRANK ZAGELMEYER.

THE CENTRAL FEATURE OF THE SHOW HELD IN CHICAGO LAST FEBRUARY.

The central feature of the Chicago Cement Show consists of no impractical statue or other idealistic and useless art effect worked out in cement, but the extremely practical and exquisitely modeled lamp posts, which have been made for the past two years, by the construction department of Lincoln Park. It was adopted so that the cement users from all parts of the great Mississippi basin can accustom themselves to the model. These lamp posts are now famous the world over. There are thousands of them used to illuminate the Lake Shore drive, through the entire length of Lincoln Park as well as both sides of Lincoln Park avenue, extending south almost to the Chicago river, a distance of several miles along the Chicago lake front and for miles along Sheridan road. This model lamp post has been copied by the Imperial Engineering department of Austria, and the magnificent capital city of Vienna is now installing this identical style of lamp post for the park system of that city. The same is true of Paris, Berlin and other places abroad. The model has been adopted and is being used in several of the parks of Brooklyn, N. Y., and even the public squares of country towns, where there is an artistic sentiment, they are to be seen.

The lamp post itself is made of concrete and encloses an iron pipe imbedded in the concrete to carry the wires up to the arc lamp, which is carried by means of a bronze cap and socket. The work of erecting the two sample posts in the center of the Coliseum was in charge of Arthur Lewis, chief engineer of Lincoln park, who has had charge of the construction department of the park for several years and has supervised the making of all of the lamp posts which form such a striking part of the decorations of that most perfect pleasure spot in the great city of Chicago.

Mr. Lewis said that the lamp posts, complete, cost about \$50.00 each. There is about one ton of concrete and the surface is treated with a veneer of fine aggregate material composed of granite screenings and white cement, while the body is of well proportioned crushed rock and sand concrete. The main expense, of course, is taken up with the bronze lamp frame and the arc lamp itself, which amounts to a little more than \$30.00. These lamp posts are cast monolithic, that is, they are poured in iron molds, which are rigidly assembled and laid in such a way that a measured amount of concrete can be laid and carefully tamped into a solid mass. The veneering is provided at the time the concrete is poured.

The model of this lamp post is particularly effective, for the reason that it is an entirely original design and appeals to the educated mind of the people of the present day. It contains none of the elements of adaptation or attempted copy of classic ideas which is the fault of many of the designs of decorative pieces we are accustomed to see.

The four sided figure is graceful in its proportions, strictly plain and beautiful, for the reason that in the simplest manner it performs its function of carrying the light with clean dignity and clear cut, well balanced lines. It is, in fact, a concrete lamp post, imperishable, and its design will be always new because it is original. We have been accustomed to see the cast iron lamp post or the wooden box to carry the park lights always so designed as to suggest the fluted column with an imperfect Corinthian cap or with an octagonal pedestal or some such classic idea incomplete and imperfectly carried out, which is always disgusting to the person of refined taste, where materials unsuited to the expression of lines that are used in the design are misapplied. Herein is the originality introduced so that the building public of the future will get farther and farther away from the ancient classic models that are no more suitable to this age than would be the sandals that were worn by the ancient Greeks or the togas of the Roman senators for the wearing apparel of today.

This lamp post, as the centerpiece of the Cement Products Exhibition, is very well taken. It is the best selection that could possibly have been made for the Chicago Cement Show, because this lamp post is distinctly a Chicago cement product, one that is the index and initial of new ideas suggesting further progress in design for all classes of decorative treatment in materials that were unknown to the ancients.

Chicago is the most modern city in the world, and it is only with modern materials such as concrete and modern ideas such as up to date people of this city insist upon having, that she shall continue to go forward until she becomes in the next decade not only the largest and richest, but the grandest and most artistic city in the world.

BLASTING SUPPLIES.

How to make effective use of powder and of the electrical equipment needed in blasting, is the subject of the latest catalogue of the E. I. Du Pont De Nemours Powder Co. of Wilmington, Del., which contains 126 pages of most valuable information, describes every tool minutely and gives all necessary precautions to be observed in handling powder. Careful reading of this catalogue and close observation of the rules set forth in this admirable publication will undoubtedly lessen accidents and enable the user to make a more effective use of his blasting utensils.

THE ALL-CONCRETE BUILDING.

On this and the following pages we illustrate the All-Concrete House, built by P. H. Bosworth, of San Francisco, Cal., after the Bosworth patents.

Mr. Bosworth has done probably more than any other contractor towards making the concrete house attractive, sanitary and within the means of every one wishing to possess a substantial residence at a moderate price.

The few photographs we are able to reproduce in this issue will give the reader a fair idea of the artistic and immensely practical temperament of the creator of these modern homes.

The method of construction of and the effects obtained by the Bosworth system show conclusively that the inventor is thoroughly familiar with all requirements for stylish and up-to-date buildings. Moreover, his way of erecting the various parts of the construction surpass in ease and elegance everything we have seen heretofore.

beauty and produces a building that is absolutely everlasting and positively indestructible.

One of the principal features of the Bosworth building is the foundation slab which is reinforced and covers the entire area of the building resting on the foundations and intervening earth. It ties the foundations and the bottoms of the first story walls together; it equalizes both lateral and compressive strains and every part of this first floor slab carries its proportion of the weight of the building. It prevents any uneven settling of the building which is a frequent cause of checks or cracks in other systems of construction.

BIG CONCRETE BRIDGE.

The engineering firm of Waddell & Harrington of Kansas City, has been awarded a contract by the city council of Pasadena to prepare plans for the new reinforced concrete bridge to be built across the Arroyo Seco at Colorado street. The city of Pasadena has



All-Concrete Residence near Palo Alto, Cal. Built by P. H. Bosworth.

The Bosworth all-concrete building is absolutely fireproof, rat, germ and vermin proof; it is sanitary and can be washed at will. It combines every desirable feature of a wooden building with none of the undesirable.

The Bosworth system of concrete building construction solves the problem of concrete residence building and includes as a part of the system the following absolutely new features:

First—Entire Monolithic construction.

Second—Reinforced concrete slab foundations.

Third—Elastic hollow wall construction.

Fourth—Interchangeable unit forms.

Fifth—Perfect concrete roof slab construction.

Sixth—Metallic fibre floating reinforcement.

The Bosworth system concrete building is the most advanced form of concrete construction yet devised. It embodies features that realize both cheapness and

voted bonds in the sum of \$100,000 and the board of supervisors will appropriate an additional \$100,000 for the project. Of this sum \$10,000 will be used for engineering fees, leaving \$190,000 for the actual construction work on the bridge. The contract with the engineers provides that the plans be completed in 40 days and it is hoped to begin actual work within 90 days.

TO DOUBLE CAPACITY OF PLANT.

Leeds, Ala.—The Standard Portland Cement Co. expect to double the capacity of their plant as soon as plans can be drawn and the buildings erected. The present output is 500,000 barrels a year.

The addition will cost \$500,000. The present investment represents that much, so that the total investment with the new enlargement will represent \$1,000,000.

Making, Use, and Care of Belting

By Chas. A. Schieren, Jr.

With the bark and the hides at hand the process of tanning to produce leather for belting may be taken up.

The hides are first soaked in pure spring water until all the dirt is thoroughly washed out of them. They are then placed in a vat of weak lime water, which is gradually strengthened until the sixth day, when the hair has been loosened sufficiently to allow the skin to be laid on a beam and the hair scraped off with a blunt knife.

The bare hides are then placed in an alkaline solution called the "bate," for the purpose of removing the lime which may have remained from the previous bath; this liming and "bating," done in a building known as the "beam house" or "lime house," is a very important step in the making of good, solid belt leather.

sticks side by side, packed as closely as possible, and are left here for about 10 or 12 days, during which the hide swells, opening the pores and increasing both in thickness and firmness.

When the hides are taken from these vats the bellies and heads are trimmed off and tanned separately for shoe purposes. The butt portions intended for belting are then stowed in vats called "lay-aways." Here they are laid flat, one on top of the other, about a hundred in each vat; loose bark is spread between the layers, and they are covered with strong tanning liquor.

Hides intended for belting are given five successive layers or treatment of bark. The first layer remains 10 days, and the process is graded up to 40 days for the last layer.

In this way oak-tanned belt leather is submitted



All-Concrete Building.

Cleansed from hair, flesh and lime, the hides are taken from the "bate" to the "handlers," where they receive their first bath of weak tanning liquor.

Preparing the Tanning Liquor.

This liquor is prepared from oak bark. Ten years ago this bark was ground in something like an overgrown coffee mill, but our tannery has been equipped for five years past with an improved crushing machine which does the work quicker and more effectively, and as the crushed bark leaves this machine it is blown by means of a rotary fan through large metal pipes to the leach tubs.

These are 12 feet in diameter, eight feet deep, and hold fully eight tons of ground bark.

To this ground bark, water is added by means of rotary brass sprinklers and filtering through the mass, takes up and carries downward the tannic acid.

There is a false bottom in each leaching tub, and the liquor is collected beneath it and pumped away to the storing and supply tanks for use when needed. It is from these tanks that the liquor is drawn for the handler vats in which the hides are put after the "liming" and "bating."

Tanning.

The hides are placed in the handler vats across

to a tanning which takes 120 days for the attainment of the best results.

Drying and Finishing the Belt Centers.

When the hides have thus been thoroughly tanned they are taken from the vats, washed, so as to remove every particle of tan bark, and then oiled on the grain side, hung up to dry in a darkened loft, where they are kept at an even temperature with very little heat, and gain a beautiful clear russet color. The leather, as such, is now completed, and each hide is cut into widths according to its grade and weight.

The bellies, shoulders and all flabby or imperfect parts are thrown out for shoe purposes, and the central portion or heart of the hide is reserved for belting.

This solid leather is carefully shaved on the flesh side in huge machines, operating somewhat on the principle of a milling machine, and is then scoured by other machinery. The object of this is to open up the pores for the reception of the stuffing of cod oil and pure beef tallow by which the leather is preserved and made suitable for the transmission of power.

Many hours are devoted to this stuffing, and the thoroughness with which it is done lends to belting one of its most prominent features—long life. When

the stuffing is accomplished the leather is smoothed and stretched so that the fibers will be made uniform.

Nothing now remains to be done at the tanneries but to allow the leather to dry, brush it off, pack it in bundles and ship it to the belt factory.

The capacity of the Dixie Tannery, of Bristol, Tennessee, owned by the Charles A. Schieren Co., is 100,000 hides a year, and its equipment is used solely for tanning and finishing prime oak leather for belting.

The leather, centers and sides, when they reach the belting factory, are from 41-3 to 41-2 feet long. At the tannery, after the leather is taken out of the vats, and before the currying process, the shoulders are removed from all of the hides, and each hide is measured four feet from the butt end of the tail to the shoulder, and the shoulder cut straight across so

this machine scarfs the laps to a length already indicated by the matcher.

From the scarfer the stock is taken to the feathering machine operator, who feathers the edges of the laps prior to their going to the pressman to be cemented. The cement used is either our improved belt cement for regular belts to run under dry conditions, or our waterproof cement for waterproof belting. Perfect joints can be and are made with no other fastening than cement, and in most cases riveting or sewing the laps is superfluous; joints that are cemented only have the advantage of running smoother and with less vibration than belts fastened in any other way.

The belt next goes to the finishing department, where it is inspected and where the edges are finished either round or square as the case may be. During the finishing of the edges the belt passes through a stretching device which eliminates all of the stretch



BUILT AFTER THE BOSWORTH PATENTS.

This View Shows the Appearance of the Concrete Roof of the All-Concrete Building. The Possibilities of this Roof are Endless; in Warm Climates it is Indispensable.

that no piece of shoulder or flanky leather is left on the hide.

After the severe stretching which these pieces undergo during the currying process and in the stretching frames the pieces elongate from four inches to six inches, making each piece four feet to four feet six inches in length, and all of the pieces solid leather.

Operations in Making a Leather Belt.

The first process at the belting factory is to select the centers and sides for thickness and weight, and cut them up into various widths for which the stock is most suitable; this is one of the most important processes in the making of leather belting.

After the leather has been cut to width it is transferred to the matching tables, where the pieces are matched in pairs and marked for the scarfing machine;

or surplus elasticity that may be necessary for good running.

The belt is next turned over to the final finishing table, where the edges are burnished and the roll made up ready for shipment and sent to the shipping department.

Every center-made belt six inches in width and over takes the central portion of one steer hide for every 4 feet of length single hide and two steer hides for every four feet of length double ply. A large main-drive belt made by us was 243 feet long and 72 inches wide, three ply thick. It took the best or central portion of the hides of a herd of 549 steers to make this belt. The average area of a steer hide when it reaches our tannery is 40 square feet. The head, shoulders and bellies are trimmed off and tanned separately for shoe purposes, and only 14 square feet, or the central back portion of each hide, is used for first-class belt-

ing. This indicates one reason why good belting is expensive.

Belt Specifications.

It is hard to suggest a belt specification which would be acceptable to every buyer and every seller, and there is a great divergence of opinion regarding such specifications. From my standpoint the following is reasonable in all respects:

1. The belting shall be short lap, cut from centers of the best oak-bark tanned belting butts, tanned with oak bark by the old slow and long-time process.

2. No piece of leather in the belt shall be more than 54 inches in length, including laps. The leather shall be cut lengthwise from the extreme end of the butt, eliminating shoulder, and offal of every description. No piece of leather in the belt shall be cut from a portion of the hide further away than 18 inches from the side of the backbone of the animal, which shows through the center of the butt.

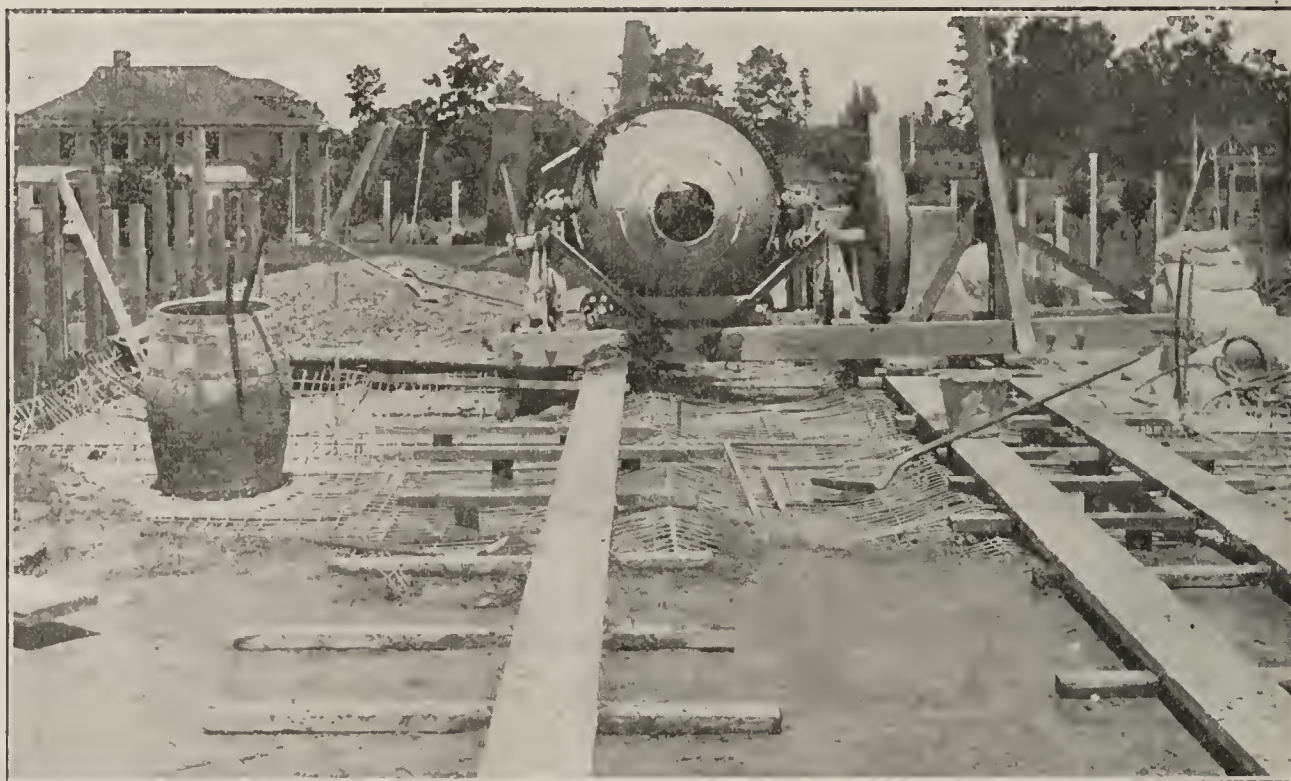
3. The weights shall be as follows: Single belts, 1 to 2 inches in width, 14 ounces to the square foot. Two and one-fourth to 5½ inches in width, 15 ounces to the square foot. Six inches and over in width, 16

securely in every part, and when pulled apart the surfaces then exposed shall show no resinous, vitreous, oily, or watery condition.

6. Tests. Belts must show an elongation of not more than 15 per cent for single belts, and not more than 13 per cent for double belts when subjected to a stress of 1,500 pounds per square inch; the elongation to be measured under stress. The breaking strain should be about 3,200 to 3,500 pounds per square inch of unstressed cross-section, both single and double ply.

Belting Factors.

Regarding belting factors there are many rules and regulations that are published and talked about. In Europe they use single belts for everything, whereas in America most of our belts above five or six inches in width are double ply. They carry the single-belt theory to an extreme and use single belts a meter wide. Their idea is that a single belt runs better and will transmit much more power than the same amount of leather put into a double belt; this, however, is not true because the transverse strain on a wide single belt weakens it, and a double belt over eight inches



All-Concrete Building. Second Story Floor Slab in Course of Construction.

ounces to the square foot. Double belts, 1 to 2 inches in width, 28 ounces to the square foot. Two and one-fourth to 5½ inches in width, 30 ounces to the square foot. Six inches and over in width, 32 ounces to the square foot.

The above weights are for the very best brands of heavy oak-bark tanned leather belting. Of course, belts lighter than these weights can be made and are lower in price. The quality of the leather is just as good but the substance of the belt is thinner. A second weight would be one ounce per square foot under the weights above enumerated, and for a very light-weight solid-stock belt the weights would be two ounces less per square foot than the weights above enumerated.

4. Laps. In single leather belts six inches wide or less, no laps shall exceed seven inches in length, or be less than 3½ inches in length. On all wider sizes of single belts no laps shall exceed nine inches in length or be less than five inches in length. In double leather belts, no lap shall exceed six inches in length, nor be less than 3½ inches in length.

5. Cement. All laps of leather belting shall hold

is a good investment for any service and is really necessary as a reserve power. In general they figure too close on the power transmission proposition in Europe and the belt gets the worst of it. Some of these ideas are coming more and more into vogue here. My opinion is that the old rules that have been used for the past 40 or 50 years are the best.

Regarding the length of belts, it is generally safe to figure that the minimum distance between centers should be three and one-half times the diameter of the largest or driving pulley.

A good transmission rule, and one that leaves sufficient reserve power in the belt, is to divide the number of feet that the belt travels per minute by 800; the result is the number of horsepower that a 1-inch single belt will transmit; in other words, if a belt will travel 2,400 feet per minute, according to this rule, a 1-inch single belt under this condition would transmit three horsepower, a 10-inch belt 30 horsepower, and so on.

A good rule for double belts is to divide the number of feet that the belt runs per minute by 500; the result is the number of horsepower that a 1-inch double

belt will transmit; in other words, a double belt 1-inch wide running 2,500 feet per minute will transmit 5 horsepower, and wider belts in direct proportion.

These are both old rules but they are safe.

It is impossible to give a hard and fast rule in regard to shortening a new belt before it is placed on its pulleys, and in regard to taking up belts that are in use. The factors for such shortening would vary with the different tonnages of the belt leather. The old long-time process of tanning gives a long-fibered leather with more elasticity, more life and more staying power than the shorter-tanned leather. A shorter fibered leather does not stretch as much as the longer fiber, and while it may have a greater tensile strength in the beginning it lacks the durability of the old-style long-fibered oak-bark tannages.

Thus, while it is impossible to lay down an exact rule regarding how much shorter belts should be cut than the actual tape-line measurement around the pulleys, it is safe to say that the average leather belt in the market today should be cut two inches short for each 10 feet of tape-line measurement; thus a belt that is to be 30 feet long when in place on its pulleys should be cut 6 inches short and this 6 inches stretched out of the belt when it is put in place.

By following this method a belt properly selected for the work it is to do should not have to be taken up at frequent intervals.

In regard to a factor for shortening belts in use the same conditions confront us as regards the different tannages of leather as have been mentioned above, that is, the short-fibered leather stretches less and has less elasticity and a shorter life. Two per cent of the length should be the maximum that a belt will stretch unless it is severely overstrained. Any belt that stretches over 2 per cent of its length is overstrained, and is liable to break if stretched to a much greater degree.

Care of Belts in Service.

Regarding the care of belts in service, belts which are subjected to extreme heat or dryness need a good belt dressing applied perhaps once every six months, in some cases oftener than this, but once every six months will harm no belt if it is properly done, and this treatment has a tendency to preserve the wearing quality of the belt.

For special service leather link belts are made for drives that have short centers, and are the only belts that we guarantee to run quarter turn; their usefulness, therefore, is limited.

Belt Efficiency.

The most efficient belt can perhaps be defined as the one that will give the maximum number of horsepower hours of service per dollar of belt investment. Sometimes engineers tell us that they wish to put in a temporary drive and that they do not expect the belt to last over three months or one year, or two years, as the case may be. On the other hand, we can point to belts that have been running day after day for some 28 or 30 years and they are still in good serviceable condition. It is evident that a larger belt investment is justified in the latter case than in the former, and such cases must be decided on their individual merits.

Perhaps a short rule for the purchaser to remember in order that he may select belts that will give him the maximum number of horsepower hours of service per dollar of investment is to design the belts with plenty of reserve capacity.

If a belt is figured according to the ordinary rule given in a previous section of this article, there is a certain amount of reserve capacity, yet it is always safe to add to this another 10 or 15 per cent for a long-life

belt. The more reserve capacity the belt has, the longer will it last and the better will it withstand sudden and severe stresses.

However, all of this is a question of good judgment and common sense on the part of the engineer or mechanic who is putting in the drive. It should be remembered that the first cost of the belt is not the only consideration, neither can it be entirely ignored. For greatest economy, all the considerations must balance.

EXTENSIVE USE OF CONCRETE CHUTES ON DRY DOCK WORK.

Dry Dock No. 4 of the Brooklyn Navy Yard is nearing completion and when finished it is estimated that 60,000 cubic yards of concrete will have been placed. This huge reinforced concrete dry dock has a length of 700 ft., a width of 110 ft., and a depth of 35 ft. over the sill adequate for the reception of a vessel 685 ft. long, 108 ft. beam, and of about 50,000 tons of displacement. This structure involves many unusual engineering difficulties and the concreting methods have attracted much attention, especially the use of the chutes.

The depth of the concrete floor is on an average 8 ft. and the mixture of Universal Portland cement is 1:2½:5. The sand and gravel are raised from the barges to the storage bin from which they are delivered directly to the measuring and charging hoppers of a 2-yd. and a 1-yd. Ransome mixer which discharge through a chute into 2-yd. wooden hopper dumping cars with vertical sliding gates. Cement to the amount of 20,000 bags is stored adjacent to the concrete plant and is elevated to the charging platform by a chain elevator. The cement is tested at the factory in Pittsburgh and is stored in bins until required.

The concrete cars in trains of three or four cars, hauled by narrow-gauge locomotives, are delivered on the exterior belt tracts to any required portion of the dock, where they dump into hoppers at the top of wooden chutes 20 in. wide and 20 in. deep that are inclined about 2½:1 and reach nearly to the bottom of the dock on centre line. These chutes are supported between pairs of wooden trusses 5 ft. deep. Through the bottom of each chute there are five holes 10 in. in diameter with vertical pipes leading from them to wooden chutes parallel with the axis of the dry dock and at right angles to the main chutes.

The longitudinal chutes have about the same inclination as the transverse chutes and are made of any required length to distribute the concrete where required on the floor, either by discharging from the lower end or through round holes made at intervals in the bottom of the chute. Ordinarily the concrete flows readily through the chute with very little scraping or hoeing, approximately equal portions of it dropping through the successive holes and pipes. Whenever necessary, however, the discharge through the different holes can be regulated by closing them with sheet-iron covers or by building dams across the chute below them. Contrary to the usual experience the concrete can be moved away from the Ransome mixers as fast as ready and the product of the plant is limited by the rapidity of supply to the mixers. The bottom is concreted in 20x135 ft. monolithic strips across the full width of the dock. Each strip contains about 675 yds. of concrete, which are continuously laid in from 14 to 24 hours, concrete being delivered simultaneously from both sides of the dry dock through two main transverse chutes.

The work is being executed by the Holbrook, Cabot & Rollins Corporation, Boston, Mr. Fred Holbrook, general manager, and Mr. C. J. Clark, engineer.

Practical Tests of Sand and Gravel

By Russell S. Greenman

That almost all failures of concrete are caused by poor cement has been a popular opinion. After some failures the "post mortem" examinations have shown that poor workmanship, due to incompetent supervision, has sometimes been the responsible cause of the failures. Those experienced with concrete have, however, found that, in addition to these two factors, the other constituent elements in concrete may be the causes for poor results or failures. These are truths which have almost become axiomatic.

The relation of intelligent workmanship to good concrete is solely a matter for consideration between the workman and the owner, it is not a question of general interest. If the owner of the proposed structure is content with poor work, that is simply his own business. The question of proper materials is, however, of general interest, for many structures are often constructed from the same group of concrete materials. The selection of those elements which with proper and intelligent workmanship shall produce good concrete is certainly important.

How to secure and select the best materials is often a problem. Apparently good sands or gravels have been selected, but not always have lasting results been secured. The method of securing for the consumer a good and safe cement has been provided. The question of securing good aggregates has been provided for in many individual cases, but a campaign of education as to the need of careful selection of the aggregates and of construction in selecting them is still generally desirable. If it is true that the bulk of the cement now produced is used by the small consumer, then this applies especially to the smaller maker of concrete and not so much to those in charge of large public works. Even here, in many cases, surprising ignorance of the proper materials has been shown.

The selection of the materials for the concrete should be made only after careful examinations and tests, either in the laboratory or on the site of the work, or perhaps both. To aid this selection certain tests have been suggested and made. It will be found, however, that there are no standard tests or methods which can be used as a basis for comparable results. It is true that some of the laboratories of large public works and some departments of our state and national government make such tests, as for example the Structural Materials Testing Laboratory of the Department of the Interior, but almost all the tests made are individual in character and have not the endorsement such as the American Society of Civil Engineers has given to the method of testing cements.

We have before us, then, the question of tests and methods. These may be resolved into two classes, laboratory tests and practical field tests. The laboratory tests should be such that practical results and conclusions can be secured; the field tests should be made supplementary to the laboratory tests and confirmatory to them, and not substitutes.

The selection of the coarse aggregates, crushed stone or gravel, is the more easily made, but sands and other fine aggregates do not so easily divide into good and poor materials. How such a division may be practically made is the topic we are to consider in this paper presented with the sole idea of starting

a discussion as to the practical tests which should be made on materials proposed for use in concrete. When reference is made to sands it will include, of course, all materials for the fine aggregate, such as natural sands, screenings, iron ore tailings, etc. Gravels generally can be considered as sands and facts concerning the one usually apply to the other.

Sampling—It is, of course, generally conceded that any testing of the constituent materials is all wasted energy unless the samples submitted are thoroughly representative. It is certainly no easy proposition to take, for instance, a sample of sand directly from the sand bank or pit; but if the tests are to be of real value, provision must first be made for securing the representative sample. What should be considered the best way, and from what place is it best to take the sample? Shall it be taken from the pit or after delivery upon the work? Sampling at the pit means that either the pit must be uniform or that extraordinary judgment must be used in selecting a sample typical of the sand, or gravel, generally in that pit. Undoubtedly the best sample from any pit is that taken from a blend made of samples taken at various places in the pit; but in some cases, even with the most conscientious sampling, the pit sample may not be thoroughly representative of the sand as it is delivered upon the work. Therefore, whenever possible, the sample should be drawn from the sand hopper or taken from the sand pile after delivery upon the work. This sample, if accepted, should be kept as the standard, and future samples, whether taken at the pit or after delivery, should be expected to equal in qualities the accepted standard.

Laboratory Tests—Having secured the sample, what are the most practical laboratory tests? The tests for strength of the mortar made with the sand and a "standard cement" is always a desirable test, but will not the tests for percentages of silt and of voids and for size and grading of the sand grains give results that form equally as good a basis for the acceptance or rejection of the sand?

In order to consider the tests more fully without entering into a detailed consideration of the methods used in determining each result, let us adopt, for the present, as our standard the apparatus and the methods used by the Structural Materials Laboratory to which reference has already been made. It is very probable that most of the larger laboratories follow the same general methods and will vary only in details. Now, having selected a definite plan of testing, do these results have a practical value in determining the relative merits of the different sands? To discuss this phase of our topic we shall use the results secured in the laboratory of the Department of the State Engineer and Surveyor of State of New York. From 34 sands selected practically at random, yet typical, from over 200 tested during the past two years, the interesting results in Tables 1, 2, 3 and 4 are noted:

A study of these results will show that a sand can be judged by its percentage of voids or of loam and by size and grading of its sand grains. As a general rule it would be impracticable to make long-time tests for tensile strength, so these tables give only the 7 and 28-day tests. Longer tests are, of course, desirable, but as we are now only considering practical tests we will endeavor to draw some conclusions

*Paper read before the American Society of Testing Materials.

from the tests at hand. We find that in Table 1 the highest tensile strength is with the lowest percentage of voids and the highest percentage of loam; and that the natural samples containing more than 3 per cent of loam are stronger than those with washed sand. From Table 2 we note that the smaller percentages of voids are secured by the sands having the best grading of the sand grains, and that the sands with the largest percentages of fine grains are the poorer. Table 3 emphasizes the fact that sands are stronger when the percentage of voids is smaller, and that the less percentage of very fine grains the better the strength. Table 4 shows that loam to a certain amount is rather an aid to strength. This statement must not, however, be construed to mean that it would be advisable to permit large percentages of loam.

From this brief statement of the results secured and conclusions drawn can it not be seen that each test is a very important aid in determining the quality of the sand under inspection? There are, of course, other laboratory tests which are of great importance in the selection of a sand; among them is notably the careful examination of the character of the sand grains.

Table 1.—Mortar Tests, Voids and Loam.

No. of sands.	10	13	11
Class.	A.	B.	C.
Tensile strength, natural:			
7-day	217	167	121
28-day	305	271	208
Tensile strength, washed:			
7-day	201	155	123
28-day	301	249	212
Voids, percentage	32.0	33.4	36.6
Loam, percentage	4.1	3.3	2.2

Table 2.—Granulometric Tests, Showing Percentages Passing Different Sieves.

Sieve.	Class of Sands.	A.	B.	C.
2		100	100	100
4		99	99	100
6		98	98	99
10		89	96	98
20		69	87	95
30		47	72	79
40		29	56	60
60		14	31	38
74		8	17	29
100		3.8	5.8	7.5
140		2.3	2.6	3.6
200		1.6	1.6	1.6

Table 3.—Effect of Voids.

Percentage of voids....	25-30	30-35	35-40
No. of sands.....	5	17	11
Average percentage	27.8	33	37.8
Tensile strength:*			
7 days	192	164	140
28 days	310	256	220
Percentage passing 100 sieve	2.8	6.4	6.7

*Results taken only of washed sample so that effect of loam would be nil.

Table 4.—Effect of Loam.

Percentage of loam.....	0-2.0	2.5-3.5	5.0-6.0
No. of sands*.....	7	6	5
Average percentage	1.0	3.0	5.6
Tensile strength, natural:			
7 days	128	181	222
28 days	254	273	324
Tensile strength, washed:			
7 days	148	178	205
28 days	261	271	310

*Sands selected which had approximately the same percentage of voids.

GYPSUM IMPORTANT INDUSTRY.

Over \$6,500,000 Production in 1910—U. S. Geological Survey Figures Show Substantial Increase Over 1909.

The importance and growth of the gypsum industry in the United States is shown by figures compiled by Ernest F. Burchard of the United States Geological Survey.

According to an advance chapter by Mr. Burchard, from "Mineral Resources, 1910," the quantity of gypsum mined in 1910 was 2,375,394 short tons, an increase of 5.4 per cent over the production of 1909, which was 2,252,785 short tons. The value of gypsum products in 1910 was \$6,514,478, compared with \$5,906,738 in 1909, an increase of \$607,740, or 10.3 per cent. The quantity of gypsum sold without calcining was 419,931 tons, valued at \$667,599, in 1910, compared with 341,855 tons, valued at \$552,509, in 1909, and the quantity sold as calcined plaster in 1910 was 1,582,186 tons, valued at \$5,846,879, compared with 1,514,037 tons, valued at \$5,354,229, in 1909. The value of gypsum and gypsum products imported in 1910 was \$502,111, compared with \$425,137 in 1909.

The largest value of output was reported from New York, Iowa and Michigan, occupying second and third places, respectively. New York enjoyed the greatest share of the increase in production of gypsum in 1910, the total value of her output having been \$1,153,977, compared with \$1,032,650 in 1909. Iowa produced \$943,849 worth of gypsum products in 1910 and Michigan produced \$668,201 worth.

Has Variety of Uses.

The bulk of the gypsum produced was manufactured by grinding and partial or complete calcination into the various plasters, such as plaster of paris, molding and casting plaster, stucco, cement plaster, fibered plaster, plaster boards, flooring plaster and hard-finish plaster. The most prominent hard-finish, anhydrous plaster is Keene's cement, which makes a very white and very hard plaster. It is used as a backing and surface for artificial marble and for ornamental moldings and castings, and its use as a wall plaster is increasing. Refined grades of plaster are used in dental work, also as cement for plate glass during grinding, for making pottery molds, stereotype molds, and molds for rubber stamps, and as ingredient in various patent cements. A large quantity of gypsum is used in the raw state as a retarder in Portland cement. Considerable quantities are ground without burning and used as land plaster or fertilizer. Smaller quantities are used unburned in the manufacture of crayons, paper, imitation meerschaum and ivory, calcimines, water paints and tints and dry colors, notably Venetian reds. When used in excess in mixed paints gypsum is regarded as an adulterant. The unburned and dead-burned forms of gypsum may be used to a certain extent with oil paints because they are not very active chemically. The partly dehydrated form is not suitable for use in oil, but can be used with water.

Gypsum was produced in 16 States and two Territories besides Alaska, and the total number of mills reported in 1910 was 80, compared with 79 in 1909. This includes mills that ground land plaster as well as those that calcined wall plaster.

Ample Capacity of Plants.

A summary of the equipment of plaster plants shows that 65 plants equipped with calcining kettles were in operation in 1910, besides two plants equipped with rotary kilns and three plants manufacturing Keene's cement. In all 190 kettles were reported.

ranging generally from eight to 10 feet in diameter, and the maximum daily capacity was reported at 13,300 tons, or an average of 70 tons per kettle. This is more than two and one-third times the actual output of plaster. At 51 plants rock gypsum alone was used, and at 11 plants gypsite alone was used, while at eight plants both rock gypsum and gypsite constituted the raw materials. Gypsum for 40 plants was obtained from open quarries, for 27 plants it was obtained from mines, and at three places combination quarries and mines were worked. At 55 plants coal was used as fuel, 13 used oil and three plants reported the use of wood.

Wide Distribution of Gypsum Deposits.

East of Mississippi river the producing localities are confined to areas in Michigan, northern Ohio, central and western New York and southwestern Virginia. West of the Mississippi deposits of gypsum are both numerous and widely distributed. The material is mined in Alaska and in 15 western States, as follows: Arizona, California, Colorado, Idaho, Iowa, Kansas, Montana, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Texas, Utah and Wyoming. Plaster Mills are in operation in at least 14 of these States.

The gypsum which is imported into the United States comes, except a few hundred tons annually, from France and Great Britain, almost wholly from Nova Scotia and New Brunswick, entering the ports of the New England and North Atlantic states. This imported gypsum is nearly all calcined and converted into wall plaster by plants along the seaboard, although a small quantity is used crude as land plaster and in paints and patent fertilizers.

Mr. Burchard's report, which contains a map showing the location of gypsum plants in operation in 1910, may be obtained free of charge from the Director, U. S. Geological Survey, Washington, D. C.—From U. S. Geological Survey.

A SELF-BURNING LIMESTONE.

Deputy Consul John D. Whiting writes as follows from Jerusalem: While making a trip through the Hauran district recently the writer's attention was attracted to a curious stone which might be described as a "self-burning limestone." Our party came upon some natives burning it and was enabled to see the operation. At this place the rock lay in a stratum between ordinary limestone; it was of a grayish black color, and when freshly broken had an odor of petroleum. Nearby were outcrops of what looked like the same material many rods long and 20 to 30 feet thick.

The quarrying is easily done with primitive picks and other tools, as the rock is quite soft and full of seams. The stone is broken into small pieces with hammers and piled up against the bank of rock. A wall of the same material about 2 feet high is roughly laid up around the pile on three sides, making a pile of small stone 8 to 10 feet long and nearly as wide, and 2 feet at the front, rising to nearly three times that height at the back where it lies against the bank.

THE CERESIT WATERPROOFING CO.

A few of the many prominent structures in which Ceresit waterproofing has been used are illustrated in a catalogue recently issued by the Ceresit Waterproofing Co. Probably ten times as many are included in a list forming a supplement to the publication.

Ceresit waterproofing has been used for many years under the most trying conditions, and has certainly proven to be one of the cheapest, simplest and most efficient water and damp proofing materials on the market, so that we must admit the claims of the man-

ufacturers have been fully justified in every instance.

The requirements for a perfect means of preventing the penetration of dampness and water through structures of all kinds, such as foundations, cellars and cellar floors, tunnels, dams, reservoirs, swimming pools, building walls, bridges, concrete roofs, cement stucco for exterior finishes, et cetera, are:

First, that the material used for this purpose shall absolutely prevent the penetration of any moisture whatever.

Second, that the material shall not affect the original strength of the cement and that its use shall be so inexpensive as to make it a means of real economy.

Third, that it may be applied to any structural material, such as brick, stone or concrete.

Fourth, that it will so thoroughly bond itself with the structural material, that no moisture can creep in or penetrate the same.

Fifth, that it shall be so thoroughly proof against water, that it will not only prevent the penetration of moisture, but will prevent the penetration of water under heavy pressure, as encountered in dam, reservoir, bridge and similar work.

Sixth, that it shall prevent disintegration of cement work from the action of frost.

Seventh, that it shall not only protect the surface of the structure on which it is used, but that it shall extend through so that in event of the surface being chipped or scratched by accident, as so frequently occurs, the waterproofing will still keep the water from penetrating through the structure.

That the manufacturers are able to guarantee Ceresit to fulfil absolutely every one of these requirements means a great deal, and will certainly not be without influence upon contractors in need of waterproofing material.

ECONOMY OF CONCRETE BRIDGES.

A municipality in New Hampshire recently obtained a satisfactory concrete bridge for less than \$75,000 after being told it would cost from \$150,000 to \$225,000. It is altogether likely, says Cement Age, that many individuals, if not communities, have been deceived by superficial cost estimates of this character. Had these New Hampshire taxpayers accepted the first statements without question, they would have had a steel bridge costing almost as much as concrete, plus an annual maintenance tax that would soon exceed the difference in the first cost of the two types, and a tax that would continue indefinitely, or during the life of the bridge. It is the popular impression that concrete always costs more than other materials, but the situation has been entirely reversed in more than one instance. Especially has this been the case in bridge construction. In the case of a certain bridge in Philadelphia, concrete was substituted for steel at half the cost of the steel. This was an unusual case, perhaps; but even at anything like equal first cost, concrete has the advantage of low maintenance charges. Furthermore, the labor and materials, except perhaps cement, are usually obtained in the locality, thus keeping in the community a large share of the money expended. Therefore, as a matter of precaution, cost estimates on concrete should never be accepted as final, unless made by an engineer or contractor thoroughly conversant with the subject and entirely free from all prejudice against concrete.

New York Cement Show, January 29-February 3, 1912.

Chicago Cement Show, February 21-28, 1912.

Kansas City Cement Show, March 14-31, 1912.

Architect and Public

By Clarence C. Bulger.

Few persons understand the correct relation of the architect to the public or appreciate its significance. This subject, nevertheless, has been thoroughly discussed in all the leading architectural publications, and is a favorite topic at the conventions held by members of the architectural profession. It is certain, however, that the people do not give the subject the attention it deserves and have come to look upon the architect as an individual with whom they have no relation except as individuals when they employ him for some special service. In such cases, they feel that this temporary relation is concluded and that they have discharged their full obligation when they have paid the fee charged by the architect for the specific service rendered. It is often the case, furthermore, that the client understands that the architect is employed to carry out the ideas of the client, and so proceeds to give him the instructions. Unreasonable as it may seem, in such cases the architect is invariably blamed when these unsought instructions do not produce satisfactory results.

The result of this ignorance of the relation of the architect to the public on the part of the people is that we have no architecture. There are, it is true, a few isolated examples of architecture in this country; but we have no National architecture. Curious enough, like other nations which have thought little of architecture, we are not famous for our music, poetry, painting or sculpture. Contrast our times with the Golden Age of Greece. Architecture was then, as the name implies, the chief art. The architect of those times was honored with the best musician, sculptor, physician, lawyer and even with the statesmen. He associated with the nobility and with the king himself. Such conditions produced the standard of architecture for all the world, probably for all time. Compare the repute in which the architect of today is held. His artistic tendencies have been stifled by the demands of commercialism. His principal study is not architecture, but human nature. The modern architect's office has been transformed from a studio into a plan shop where designs are turned out and sold like merchandise.

Now let us compare the relation of the architect to the public as it exists, and as it ought to be. The most striking feature of the attitude of the average individual toward the architect is that "one is as good as another." A typical illustration of this point is derived from an actual occurrence. A prospective builder had been referred by a friend to a certain architect on whom he called, but, failing to find him, passed on until he found another. Other cases, more excusable, perhaps, are those in which social relations, or any other influence aside from actual merit, have deciding influence in the selection of an architect. Where competitive drawings are resorted to, the architect presenting the most attractive picture is usually chosen, but occasionally the "smooth talker" has success. Few realize their inability to judge the merits of an architect from pictures. The fact is, only an expert is capable of so judging, for it is often the case that a design has to be distorted, and features added which seem to throw the picture out of balance and proportion, in order that the building when erected may have the desired balance and proportion. The tapering of columns is done that they may appear straight; domes are made slightly elliptical in shape that they

may appear round. Thus real merit is often the cause of the defeat of the conscientious architect and the superficiality of the unscrupulous "mediocrity" the basis of his success. This is not only injustice to the worthy individual but blighting to his art.

Now consider the proper attitude of the prospective builder toward his architect. He is building for the future. He considers that what he is about to build will stand as a monument or as a blot on the community for at least a quarter of a century. He proceeds cautiously and inquires among those who have built successfully as to their architect. He is not yet satisfied, and so he studies the subject himself and keeps his eyes open as he passes along the streets and in his travels. One prospective home-builder spent days selecting houses in different parts of the city which he considered to be well designed. On inquiry later he was surprised to learn that all the houses he had on his list were the work of the same person. It was not difficult then for him to select his architect and the latter had no difficulty in producing something which pleased him, and, at the same time, was a credit to the community. The lesson to be derived by the architect from this incident is: Study, travel, thought, and hard work, all devoted to the attainment of the most successful combination of the artistic and practical. These are the attributes of an architect which are appreciated and demanded. Compare the inevitable lessons to be derived from the existing and prevailing attitude toward the architect: Be "Johnny on the spot!" Advertise! Go after the business! Get it out quick! Study your client! Make your pictures attractive! And give them what they want!

How few realize that their carelessness in this matter not only produces poor results for themselves and their neighbors, but slaps the conscientious practitioner in the face and undermines the very foundation of true merit!

This lamentable condition is best studied by its fruits. One has only to look about him in any American city to witness the havoc that has been wrought. Not only is the average design poor and even ugly, but the surroundings are ill adapted. Often we have an exceptional design ruined by the environment. Nothing so exhibits the fallen nature of mankind than the character of buildings he erects. One has only to look upon a rose, or a tree, or upon any other object of nature and compare them with the work of man to realize this. To some extent, therefore, architecture is a telltale of the financial, intellectual, aesthetic, moral and spiritual condition of a community. If the churches are inferior and neglected, then it is safe to assume that religious zeal is lacking; if the public buildings, such as libraries and schools are poorly built and poorly equipped, education is not considered of great importance; if the municipal buildings are inferior, it is a sign of lack of enterprise and public spirit; if the homes of the people show indifference, the indication is there is moral and financial decline.

Furthermore, the lack of individual interest in this subject is encouraged by indifference on the part of public officials, the disastrous consequences of which can be seen on every hand. In most American cities there is an utter lack of regulations in building operations. A person may build almost any kind and design of a building, anywhere he may own the ground, thereby reducing the value of his neighbor's property

greatly, and sometimes destroying it for the purpose for which it was intended. The law provides for the punishment of the thief who enters upon the premises of a citizen and robs him, but there is no protection to the property owner who has spent much thought, time and money in making his neighborhood desirable and attractive, only to make it the more attractive to the speculator building cheap houses, who can and does charge more rent for his shacks on account of the desirable surroundings produced by others.

The effect of such lack of protection upon the home builder can be easily discerned. It is a common thing for a client to state to his architect that he is not particular about the external appearance of his house, provided the interior arrangement pleases him. This is to say, that he does not care about his neighbors, but is solicitous only for his own comforts. We have noted on the other hand that where regulations exist as to the kind and quality and style of houses that may be built upon a certain piece of property, as is the case in private additions, the client takes the opposite position. He knows that his neighbors will be bound by the same regulations and so he feels safe in expending his hard-earned funds in the production of artistic exterior effects. Sometimes he instructs his architect to leave off the finishing of some of the rooms and omit some conveniences in order that the exterior may be made as attractive as possible within his means. It may seem, on first thought, that such a treatment of a house is a pretense or sham. On the contrary, it indicates unselfishness and altruism, for his neighbors and passersby get the benefit while the owner sacrifices his comforts.

We are led to believe, therefore, that one of the principal reasons for the indifference of the individual in matters pertaining to architecture is the almost criminal indifference on the part of the government. The national government has realized its responsibility in this matter and is setting a higher example throughout the country. Many municipal governments are beginning to realize the importance of their influence, and are employing experts to lay out the cities along artistic lines. It is gratifying in the instances where work has already begun, to note that the improvements in the artistic also carry with them improvement in the materialistic, and that art and business are not in conflict. All authorities are agreed that in the movement in favor of the "city beautiful" which has taken hold of American cities, a brighter day is dawning for American architecture, and that American architects will probably live to see the day when their relation to the public will be better understood and appreciated.—Dallas Architect.

One of the biggest gravel road contracts ever awarded under Indiana's three-mile road law was let July 11 to John F. Cronin & Co., of Richmond, Ind., the contract price being \$52,000 for the road proper and approximately \$2,500 for a dressing of asphaltic cement, to be used on that section of the road within the city of Richmond. The road to be improved is the historic National road, from a point in West Richmond to the boundary line of Center township, a trifle less than three miles west of Richmond. The stretch of road to be constructed will be wholly unlike any other highway in the state. Cement curbs and gutters will flank the roadway its entire length. The road itself is to be constructed of crushed stone, with cement filler, and the whole is to be pressed into a solid mass with ten-ton road rollers. The width will be forty-five feet.

THE OHIO & WESTERN LIME CO.

Peter Martin, president, general manager and treasurer of the Ohio & Western Lime Co., first started in the lime business in Huntington in 1877, says the Huntington Herald. At that time M. Baltes, Jas. Lilly, Adam Beck, E. S. Wheeler, Hawley Bros. Lilly and Schumaker and others were owners of separate concerns.

In a few years the Huntington White Lime Company was organized with W. W. Hawley as its first president. This company lasted three years and then the Western Lime Co. was organized with Peter Martin as president, general manager and treasurer. This company absorbed the separate interests and made one large company. A short time later Mr. Martin organized what is known as the Tri-State Supply Co., which included all the lime producers in Indiana, Ohio, Illinois and Michigan. Shortly afterward the Ohio & Western Lime Co. was organized and this company now has its chief office in Huntington with lime works at Huntington, Bedford, Marion, Ohio; Fostoria, Ohio; Gibsonburg, Ohio; Tiffin, Ohio; Genoa, Ohio; Lucky, Ohio; Sugar Ridge, Ohio; Limestone, Ohio; Lime City, Ohio, and Portage, Ohio.

The daily capacity of the company is 8,000 barrels of lime and the capital is \$1,500,000. The company manufactures a great many different kinds of lime. The lump variety made at Bedford is the strongest and is used mainly for water purifying and chemical purposes. The ground lime made at Tiffin, Ohio, is used exclusively for the manufacture of glass. The company also ships 600 carloads of lime annually for agricultural purposes. It operates four large hydrating plants. The hydrated lime or the new process lime is prepared in such a way that it is very fine. It is used for all building purposes and is put up in sacks of paper and burlap.

At Huntington the company has erected a large hydrating plant to take the place of the one that burned a year ago. The lime industry is one of Huntington's foremost industries. Lime can be made here on account of the fine grade of limestone found underlying almost the whole of Huntington county. It gives employment to many persons in Huntington.

SAND AND GRAVEL BOOKLET.

The Chicago Portland Cement Company, Chicago, Ill., has just issued, for general distribution, a booklet treating of "Cement, Sand and Gravel for Concrete." While the subject is one that has received a great deal of attention during recent years, it is sometimes an advantage to have set down in type the essentials involved, to which exception cannot reasonably be taken. Moreover, it seems desirable to call attention to the fundamental requirements of good concrete construction with sufficient frequency to prevent their being overlooked in the face of the general demand for low cost.

"R. F. & C." RUBBER BELTING.

The Electric Hose & Rubber Company, 522 Howard street, San Francisco, is distributing card and folder describing and illustrating the good points of the "R. F. & C." rubber belting manufactured by the Buffalo Weaving & Belting Company. The point is made that the belt is a solid woven cotton fabric, built up in looms on scientific principles whereby a maximum of strength and a minimum of stretch is obtained. The belt has splendid records of service in cement works, steel mills and so forth. R. C. Brinkley, at 318 First Avenue South, is the Seattle representative of the company.

PROGRESS IN CEMENT VAULTS.

While there has been great progress in all branches of cement work during the past few years, not only in the various useful articles made of cement, but in modern machinery to be used in every line of cement work, this advancement is still going on and will no doubt continue to make the use of cement products still more and more universal.

One of the latest improvements and one which is a marked advancement in cement products, is that of the automatic sealing vault, a cut of which appears elsewhere in the advertisement of the Automatic Sealing Vault Company in this issue of our paper.

This vault was invented and patented in 1909 and is certainly far in advance of other cement vaults which heretofore have been manufactured. The designer has made this vault in such a manner as to exclude water absolutely without it being necessary to use fresh cement in the sealing device in closing the vault. In fact, it may be said to be a jointless vault. They base their claims on the practical test of atmospheric pressure which is about 15 pounds per square inch.

The vault is constructed in such a manner that when water rises above the flange of the lid, it seals the air in the vault, therefore rendering it impossible for water to enter. This principle is very simple and yet very effective and it can be proven in various ways that their claim for this vault is all that it is recommended to be by the inventor.

The same company which owns this vault has also developed an adjustable steel mold which is worthy of the most careful investigation of any cement user. While these molds are adjustable and make several different sizes of vaults, yet they do not leave the walls of the vault rough. In fact, they make the vault as smooth as it is possible for a vault to be made in molds as there are no rivet heads or projecting parts which mar the surface of the cement.

They do not use bolts or turn buckles or set screws in the fastenings of these molds but instead, the molds are made by simply slipping rods through adjustable holes which are made accurate for the purpose. With this system, it can readily be seen that the molds are very convenient to operate and are held accurately to place.

METHOD OF TINTING CONCRETE.

Considerable interest is being shown in the tinting of concrete when it is used for residential purposes. Undoubtedly the work can be done successfully with certain colors. Concrete can be tinted green, for instance, by the use of chromium oxide, in proportions of approximately 5 to 8 per cent of the weight of the cement used. A yellow or buff tint can be obtained by the use of French ocher in the percentage of 4 to 10, according to the shade desired. Red is obtained by the use of red oxide of iron, that manufactured in Germany or France preferred. A pure white concrete, says Contract Record, can be made by the use of 1 part white Portland cement and 2 parts marble screening, tough, hard marble preferred, the screenings to pass through a No. 8 screen and be collected on a No. 40 screen. It should be mixed fairly wet so that it will run into the molds. The molds should be slightly rocked and jarred, so as to expel the air bubbles. For some characters of work the concrete can be made not quite so wet, but of about the consistency used by brickmasons in laying brick, and pressed in the molds. As soon as the concrete is hard, say in three or four days, it should be rubbed well with a fine terrazzo polishing stone. This will give the appearance of a white polished surface.

THE MARION SHOVEL AND DREDGE COMPANY.

Wish to take this means of advising our customers and others with whom we have had business relations, that owing to the purchase of the entire business including patents, designs, patterns, good will and name of "The Osgood Dredge Company of Albany, N. Y.," that in order to perpetuate the name we have consolidated under the name of "The Marion-Osgood Company."

The home office is located at Marion, O., on East Center street, opposite Hotel Marion. The eastern office of the company is located at No. 51 State street, Albany, N. Y., with Mr. John K. Howe in charge as consulting engineer and eastern sales manager.

Our shops are located at Marion, O., just south of the city, between the Hocking Valley and Pennsylvania railways and we have direct connections with both of these roads. Our plant is now in operation and is equipped with the most modern and up-to-date machinery which will enable us to turn out the highest grade in our line of manufacture at the lowest prices.

We will manufacture a full line of steam shovels, dipper dredges and ballast unloaders of the general types which by long use have become standard, but in our new designs all of the weak points will be eliminated either by added strength or improved construction, making them the most durable, efficient and economical machines on the market.

This new consolidation is not to be confused in any way with "The Marion Steam Shovel Company" of this city, but is a new and entirely distinct concern with no connection with the old one, except that some of the officers formerly held positions with The Marion Steam Shovel Company. Our secretary and general manager, Mr. A. E. Cheney, was for about twenty years secretary and sales manager of the Marion Steam Shovel Company; our chief engineer, Mr. H. J. Barnhart, was chief engineer for the Marion Steam Shovel Company for about eighteen years; most all of our leaders have had many years of experience with the above mentioned company.

We have delivered a 1½-yd. shovel to Mr. H. S. Kerbaugh of Philadelphia, Pa., and have orders for two 6-yd. shovels for Mr. Kerbaugh. We are building a 4-yd. dredge for the Empire Engineering Corporation of New York City and we are well along with a 1½-yd. dredge for the United States government for use on the Tennessee river. We have our drawings and patterns well along and the work started on a shovel built to handle a 2½ or 3-yd. dipper.

If in the market for anything in our line, we shall be pleased to submit specifications with prices upon receipt of full information.

GOUVERNEUR BUILDS MARBLE ROADS.

The village of Gouverneur, N. Y., is making the experiment of building its highways of crushed marble and asphalt. The foundation is laid in crushed marble well rolled. On this is poured a coat of hot asphalt and on top of that a covering of the crushed marble is placed and rolled, the asphalt acting as a binding. The entire cost of construction aggregates about \$1,800 a mile. This is more than has been expended in road construction heretofore, but the marble highways give such excellent satisfaction that the work will be continued on a larger scale than was originally contemplated.

A TALL CONCRETE STAND PIPE.

A 120,000-gallon stand pipe measuring 82 ft. from top of foundation to bottom of cornice has been erected at Waverly, Ohio, the cornice and roof are 4 ft. higher, making the total height 86 ft. The overflow, located 18 in. below the top of the shell, allows for a head of about 80 ft. of water in the tower. The foundation, "Cement Age" reports, is octagonal, 22 ft. in diameter and 7 ft. deep; it is made of concrete, 1 part Portland cement, 3 parts sand and 4 parts gravel with enough water to make a "quaking mix," but not slushy. When within 18 in. of the top of the foundation the first reinforcing steel was placed consisting of $\frac{3}{8}$ -in. rods bent at right angles with about 4 ft. of rod resting on the foundation and spaced 18 in. on centers so they would stand 4 in. from the outer side of the shell. One piece of $\frac{5}{8}$ -in. steel was placed in the angle and the perpendiculars were wired to it. The foundation was completed with a mixture of 1 to 2 to 2.

The shell for the first 9 ft. is 12 in. thick, the next 45 ft. is 9 in. thick, and the balance 6 in. thick. The roof is 4 in. thick. The outside of the shell is perpendicular, and the reductions in thickness are made on the inside. The reinforcement consists of $\frac{3}{8}$ -in. perpendicular rods and $\frac{5}{8}$ -in. horizontal rods spaced according to pressure requirements, from eight rings at the bottom to three rings at the top for each foot of height. The same mixture of 1:2:2 was used throughout the shell, using no gravel that would not pass a 1-in. mesh and making mixture very wet or slushy. Metal forms were used in three sections. Scaffolding was placed on the outside, and material was hoisted in wheelbarrows with a small derrick. The tank cost about \$4,500. Mr. H. C. Babbitt, of Lockland, Ohio, was engineer, and Mr. J. L. H. Barr of Batavia, Ohio, contractor.

Construction was begun late in the fall of 1910, and when about half completed work was suspended on account of cold weather. The job was finished in February, 1911, and under these circumstances was completed in sixty days.

HESS FLUME CATALOG.

A brand new idea, fresh from the breezy West, comes in the form of a most unusual and original catalog, just off the press, gotten out by the Hess Flume Company of 635-636 First National Bank Building, Denver, Colo., showing their metal flumes as used for irrigation, power, mining and substructures for various purposes.

But this catalog is not only unique and interesting, for it contains much information on the subject of flumes in general that is of real value. Two pages are devoted entirely to tables of the carrying capacity of different sized flumes and various specifications. These will be of much help to the engineer, or in fact to anyone figuring on flumes.

The Hess Company claims two most conspicuous advantages for their improved galvanized Toncan metal flumes. First, the fact that they are made of Toncan metal sheets, supplied by the Stark Rolling Mill Co., Canton, O., which are claimed to be particularly adaptable to meet the severe conditions and exposure to which all flumes are certain to be subjected. Second, they claim that the Hess is the only flume with a perfectly smooth interior. The interlocking sections are easily assembled, and a water-tight joint is secured without the use of either solder or rivets. This joint offers absolutely no obstruction to the flow of water.

Their unique catalog of course illustrates this joint, and the pen pictures show in detail the construction of the Hess flume, bringing out clearly their many

Ceresitized Concrete and Cement Mortar are Permanently Waterproof



CASTLE OF THE EMPEROR OF GERMANY
Built at Posen in 1908. Waterproofed with Ceresit
Waterproofing with completely satisfactory results.

and possess the highest efficiency at the lowest cost of any known method of waterproofing. Ceresit is a cream white paste which is incorporated in the concrete mass of cement mortar. It is put into the water used in mixing the ingredients before the mixing is done. The water carries the Ceresit into every portion of the mass uniformly—thoroughly and renders it absolutely water tight when in the structure.

"Ceresit"
Waterproofing

is guaranteed to be an absolutely unfailing water repellant and thus protects concrete structures from disintegration and damage from frosts.

Ceresit makes concrete denser; does not alter its color and does not lessen the tensile strength of the concrete.

There is no known method of waterproofing, regardless of cost, that is more efficient on important concrete engineering such as tunnels, foundations, sewers, bridges, reservoirs, dams, tanks, swimming pools, water-towers and tanks, floors, cellars, walls and roofs.

Ceresit is also applicable for use in cement mortar and will damp-proof and water-proof structures built of concrete, brick, stone or tile. It is also used in cement mortar coatings on stucco and cement plaster surfaces.

Write for our Free Book "Q" and try Ceresit on your next job.

Ceresit Waterproofing Company

Clark and Adams Streets, CHICAGO, ILL.

Branches: 1133 Broadway, New York City, N. Y. 1218 Chestnut St., Philadelphia, Pa.

AGENTS WANTED IN UNOCCUPIED TERRITORY

Please cut out this

REMINDER

to write Ceresit Waterproofing Co., Clark and Adams Streets, Chicago, for Book "Q" on Waterproofing Concrete and Cement Mortar.

other advantages. At the bottom of each page are different little pert reminders, in bold handwriting, that the Hess flume is made of rust-resisting Toncan metal sheets. The other lines, metal lumber substructures, metallic intakes and outlets, headgates, pressure pipe are each briefly mentioned and described. Judged from both the standpoint of originality and from that of practical utility, the Hess flume catalog is certainly a most unique and interesting book, well worth the perusal of everyone interested in flumes in any way. Send for a copy.

NEWS ITEMS.

A company was recently incorporated in the State of Wisconsin, known as the Wisconsin Mausoleum Construction Co., consisting of aggressive and able business men well known throughout the state. It will operate under patents secured by The United States Mausoleum Company, of Fremont, O., incorporated under the laws of the State of Ohio, issued to it by the United States Government Patent Office, covering certain methods of mausoleum construction and improved devices for the perfect sanitation of crypts, which positively destroy all odors and germs of disease. As mausoleums have been built for centuries past, it does not claim exclusive right to build mausoleums. Its claims are on sanitary methods of building and operating community and private mausoleums, which have never before been used in the history of the world.

The United States Mausoleum Company has sold the exclusive right to the Wisconsin Mausoleum Construction Company, of Milwaukee, Wis., to erect

mausoleums agreeable to these patents issued at Washington, D. C., in the county of Milwaukee and contingent rights in the entire state of Wisconsin.

The construction of these modern mausoleums will be of specially prepared concrete or artificial stone. The outer building will be independent of the inner structure; not even will the foundation walls be connected in any way. The exterior walls, it is claimed, may be removed or rebuilt at any future time without injury to the interior or catacombs.

The General Cement Products Company, New York, N. Y., has shipped to the Isthmus of Panama a pneumatic spraying machine for coating surfaces with concrete mortar. The machine is to be tested for a month in coating the surface of the rock in Culebra Cut.

Concrete pipe has won a notable victory at San Diego, Cal., being adopted in preference to ordinary vitrified sewer pipe for a large amount of new work to be done in that city.

The Louisville Cement Company, for which J. B. Speed & Co. are selling agents, has announced a new brand of cement under the name of Alca. It is neither a hydraulic nor a Portland cement, but is manufactured by burning the various materials entering into its composition separately and then grinding them together. The new product is intended to be used in heavy foundation work, and is cheaper than Portland cement. Henry Gray, treasurer of the company, announced that there had already been an excellent demand for it.

> FLINT-RIM <

The Most Economical Sprocket Wheels on the Market

Last several times as long as ordinary cast-iron wheels, and cost but little more

Are accurately fitted to the original "Ewart" chains, of which we are the designers and makers



Life of chain prolonged, because wheels are not rapidly wearing away from the proper pitch diameter

Write for Catalogue

Trade Mark. Reg. U. S. Pat. Office

The economy resulting from the use of these wheels appeals to all who appreciate durability and satisfactory service, and especially to those who wear out machinery rapidly in handling Raw Materials in Cement Mills, Phosphates, Crushed Stone, Ashes and other abrasive materials

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NEW ORLEANS, Wilmot Machinery Co.

BUFFALO, 601 Ellicott Square

BOSTON, 131 State Street

JEFFREY'S SEATTLE BRANCH.

The Jeffrey Manufacturing Company of Columbus, Ohio, manufacturers of mining, elevating, conveying and power transmission machinery and coal mine equipment have recently opened another branch office at 1201 American Bank Building, Seattle, Wash. from where they will handle their business in the Northwest.

Mr. Percy E. Wright, their Seattle manager, is a sales engineer having been connected with the home office for the past ten years and is thoroughly conversant with the conditions in the Northwest territory, having been traveling in this part of the country for a number of years.

The Jeffrey Manufacturing Company are maintaining thirteen branch offices in the United States, as well as nearly 100 agencies in the leading commercial centers all over the world.

SAND-LIME BRICK.

The Flint Sandstone Brick Company, Flint, Mich., recently stated:

"We expect to begin the delivery in ten days of 1,300,000 sand-lime brick for the Olds Motor Company's new building at Lansing, Mich. This is a fine job and will serve to introduce our brick in great shape."

The Buffalo Sandstone Brick Company reports that it has sold all the brick in stock and has orders in sight for another three months' business.

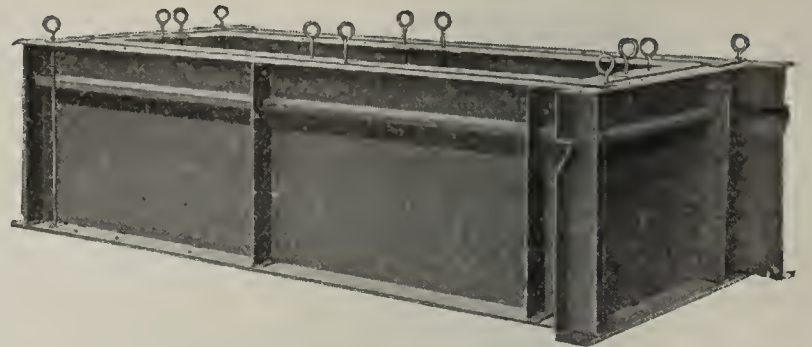
The eighth annual meeting of the American Association of Manufacturers of Sand-Lime Products will be held at Grand Rapids, Mich., December 5 and 6. The opening session will be held at 10 a. m. All meetings of the association are held in executive session and only members with their invited guests may be present at the meetings. It is expected that there will be a full attendance this year for the members of the association are unanimous in saying that it has been the means of saving the day for many of them and that each year it proves of greater value.

These annual meetings are of inestimable value to those attending for they meet practically every successful manufacturer of sand-lime products in the United States and Canada. One of the rules of the association is the exchange of experience for the mutual benefit of all the members. This enables many of the manufacturers to avoid a number of the earlier difficulties natural to a new industry, and place the business upon a successful basis, both as to quality and financial results. No manufacturer of sand-lime products can afford to lose the benefits of the association or fail to attend the annual meeting.

While the association has a standing committee on information to whom questions and troubles can be referred at all times and prompt answers received, at the same time the value of two days in the company of men of experience in your line of business, who will answer all questions freely and honestly, must not be overlooked. Before or after the meeting all the members of the association are invited to visit the new sand-lime brick plant at Kalamazoo, Mich., where the new process introduced by the Jackson & Church Company is in operation. An invitation has also been received from the Grande Brick Company, at Grand Rapids, requesting the members to visit their plant.

Frank Plato has purchased the concrete block factory at Bridgeburg, N. Y., from Doval Campbell.

HERE'S SOMETHING YOU WANT

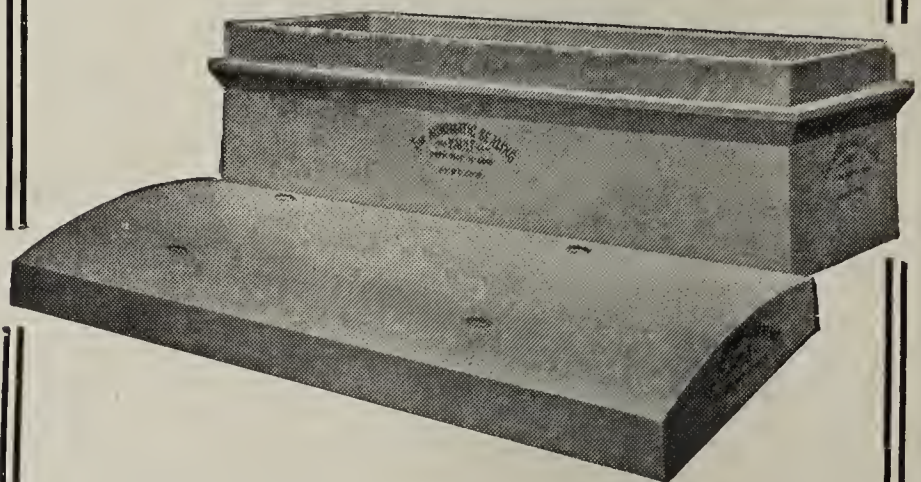


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EVERY man is looking for the product in his line that will make him the most money. You can't beat the Automatic Sealing Vault for a money maker. It's the *greatest burial vault known today* and hundreds are being used. It is manufactured with the *finest* and most practical *adjustable steel molds* ever produced. Undertakers are anxious to handle this vault for they know that it is a seller. It's the vault that will pay you for making it. Get our prices on molds and learn our territory arrangement.

AUTOMATIC SEALING VAULT

*More beautiful than stone or steel.
As enduring as the ages.*



Tear out this ad and write us today and you will get our beautiful illustrated booklets.

The
AUTOMATIC SEALING VAULT CO.
Peru, Ind.

NOTE—Try an order of the A. S. V. Waterproofing Solution especially prepared for all kinds of cement products requiring perfect waterproofing. Put up in five gallon cans at \$1.00 per gallon.

The plant of the Wolverine Portland Cement Company at Quincy, Mich., has started up for the season, giving employment to 150 men. The old officers were re-elected for the ensuing year.

The Vancouver Portland Cement Co., Tod Inlet, B. C., have recently purchased from Pfeiffer Bros., Kaiserslautern, Germany, seven sieveless ball mills, four equipped with separators and three with air selectors.

Three hundred men went back to work recently at the Iola Portland Cement Co.'s plant, Iola, Kans., after a winter shut-down of three months. Previous to the shut-down the plant was in continuous operation for about ten years. In the interval of idleness the plant has been thoroughly overhauled and repaired.

The Norfolk Portland Cement Corporation has resumed operations on full time at Norfolk, Va., employing about 300 men.

Mr. J. S. Irvin has returned to Ottawa, Canada, after a three months' stay at Spokane, Wash., where he organized and was elected president of the International Portland Cement Co.

The Albert Mfg. Co. of Hillsborough, N. S. whose plaster mill was recently destroyed by fire, will rebuild the plant at a cost of \$100,000. C. J. Osman is manager.

The Canada Cement Company have decided to double the capacity of their plant at Lakefield, Ont. A great deal of construction work is going on beside the work of adding new machinery, etc. A. S. Batchart, manager.

The Sterling Machine

Makes Plain or Ornamental Bricks or Blocks

It is so constructed that any size of brick or block can be made. It is simple in construction and having a mechanical tamping device, is a labor-saver.

Fifteen Days' Free Trial

We guarantee the Sterling Brick and Block Machine to give perfect satisfaction in every way. To prove it, we will ship this machine on trial, use it for fifteen days, if it does not come up to your expectation at the end of that time, return it at our expense.

Compare this Outfit with Others

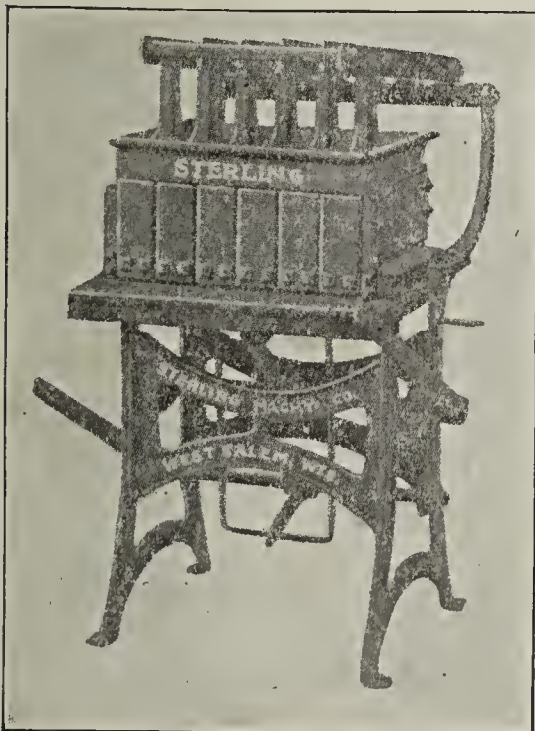
and consider its value. Never before was an outfit offered anywhere near the price we ask. It includes everything to go into a profitable business. With every machine we send a book of instructions fully explaining how to work the Sterling to your profit.

Interested? Then write us and we will either send the machine or further information and price, just as you request.

Do it now. There is Profit in it for you.

STERLING MACHINERY CO.

WEST SALEM, WISCONSIN.



Send for this book of DOLLAR FACTS

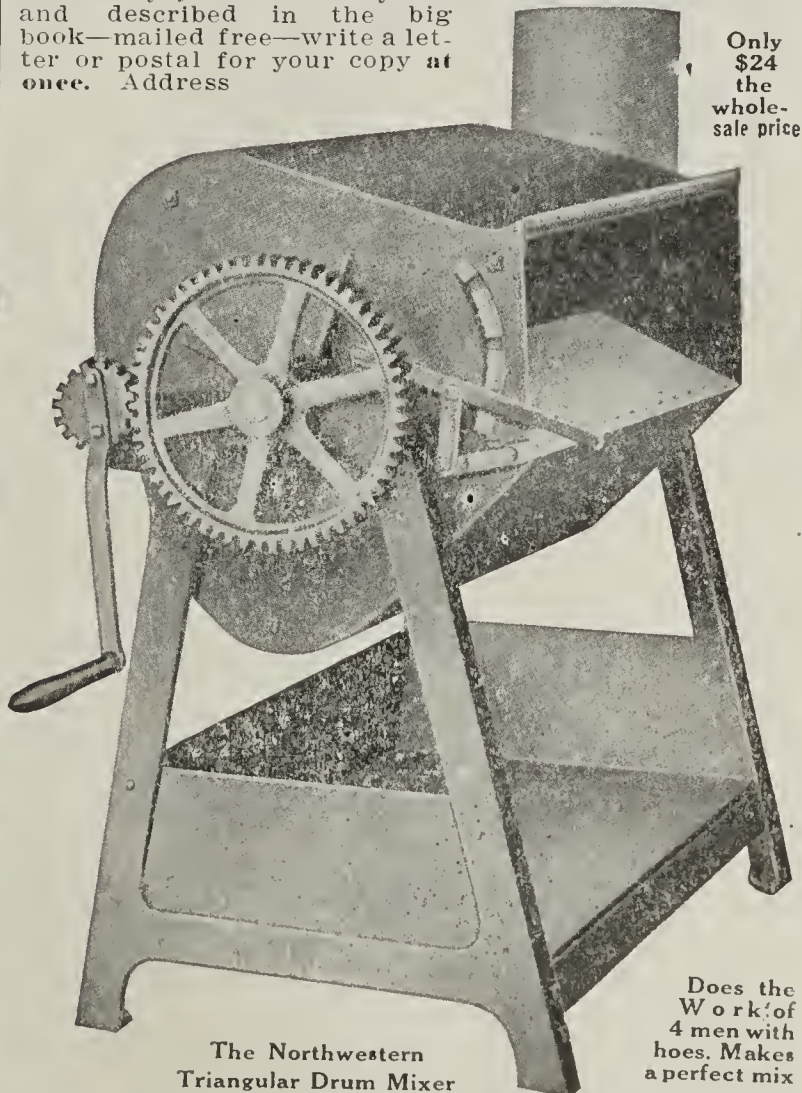
Don't lose a minute—send right now for this big book of concrete machinery and prices that will save you dollars and earn you dollars in the cement business—wholesale prices that will astonish you. We operate the largest factory in the world devoted to making concrete machinery. We make block machines, brick machines, post machines, silo machines, ornamental moulds, concrete workers' tools, cinder crushers, gasoline engines to operate concrete machinery. You'll find all these and many more in our book. Send for it now.

Northwestern Concrete Machinery

Your success in the concrete business depends on your ability to turn out the best work at moderate prices—prices below your competitors. With an equipment of Northwestern Cement Machinery the battle's half won. Their efficiency and low cost of operation will back you and carry you through the most difficult jobs and make you good money on every contract.

Built in all sizes—all prices—you'll find just the equipment you need, whether you're starting in a small way or have already built up a large business. Machinery you need today or in the future illustrated and described in the big book—mailed free—write a letter or postal for your copy at once. Address

Only \$24 the whole-sale price



The Northwestern Triangular Drum Mixer

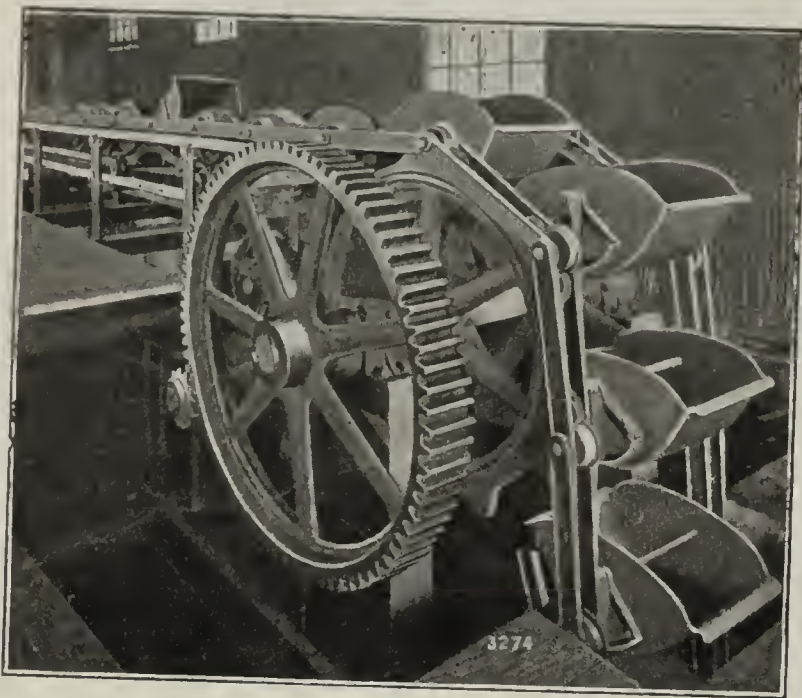
Does the Work of 4 men with hoes. Makes a perfect mix

Northwestern Steel & Iron Works

935 Spring St., Eau Claire, Wis.

PECK CARRIER

a conveyor-elevator consisting of malleable iron buckets
(that overlap on the horizontal runs) attached to roller chains



Descending turn of PECK CARRIER showing bucket
on horizontal run tilted into emptying position.

The corner turns are made around wheels---just a simple change from one run to another without interfering with the natural carrying position of the buckets.

For rules of correct conveying, as well as descriptions and views of various installations, see our Book No. 81. Address nearest Office

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The Calcium Silicates and Calcium Aluminates Contained
in Portland Cement - - - - - 50 Cents

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How to Use Portland Cement - - - - - 50 Cents

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THE USE OF CONCRETE IN AUSTRALIA.

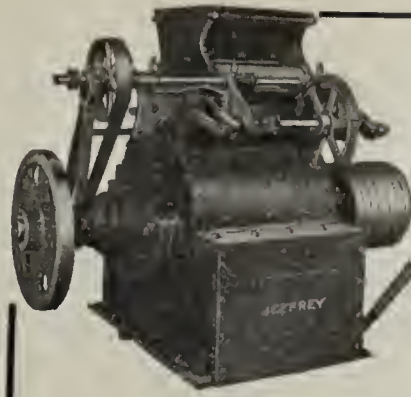
The Daily Consular Trade Reports of Jan. 7, contains several interesting reports concerning the use of concrete and cement machinery abroad.

Vice-Consul-General Henry D. Baker, of Sydney, writes as follows:

The increasing use of Portland cement in Australia for the construction of public works, private buildings, etc., where concrete is required, has led to recent advances in prices, so that in mid-October Portland cement was quoted in Sydney for the best brands, at \$3.28, spot, per cask of 375 lb.; second brands, \$3.05 to \$3.15; local brands, \$3.15.

At these prices local manufacturers are said to be making profits of over 100 per cent on the cost of production. Nevertheless, as they are unable, with their present plant capacity, to keep pace with the growing demand, the users of cement have recently been obliged to make extensive imports from other countries, chiefly Germany. The scarcity of cement has of late been a source of some delay in important public works. Although it is the policy of the various state governments in the construction of works to buy cement only from local manufactures, an exception lately has been made to this rule, owing to the inability of local plants to supply what is required.

As there are rather extensive cement deposits in different parts of Australia, chiefly in New South Wales and Tasmania, and the local industry is protected by a tariff of 24 cts. per 112 lb. as well as by the disposition of the local governments to patronize the local product, it is likely that in the future there will be considerable development of this industry in Australia to meet the increasing needs of consumers.



Jeffrey Pulverizers

for Cement, Limestone, Gypsum, etc., have larger capacities, yield more uniform product and cost less per ton output than any other pulverizer on the market.

Jeffrey Swing Hammer Pulverizer

size 36 x 24 inches, capacity 12 tons Lime stone per hour. 75% will pass 80 mesh.

Write for Catalog 31

Jeffrey Elevators

for handling Coal, Ore, Gravel and Cement Clinker. Adapted for high lifts, heavy work and large capacities.

Conveyors, Screens and Power Transmission Machinery

Catalog mailed upon request

The Jeffrey Mfg. Co.

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This Chain Runs Smoothly with Positive Action

MANITOWOC CEMENT KILNS DRYERS COOLERS, ETC.

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Manitowoc, Wisconsin

Chicago Office 524 Monadnock Block

CHARLES F. MCKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

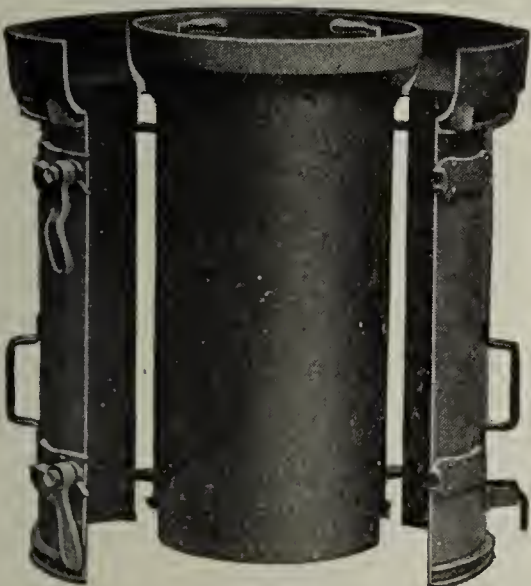
Consulting and General Practice in Chemistry, Technology, Chemical Engineering and Chemo-Legal Cases.

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"SUCCESS" Sewer Pipe and Drain Tile Molds

Are BEST by TEST. Makes Bell End Up. NO CAST IRON PALLETS NECESSARY

They are so easy to operate that a boy can make tile with them.

With our Combination Mold either Bell end, Tongue and Groove or Straight Drain Tile may be made. Thus you can supply all demands without buying a separate mold for each style. WE ALSO MAKE MOLDS FOR THE POURING SYSTEM.

Our Terms are very favorable. Spend one cent for our free catalog and proposition.

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BLYSTONE BATCH MIXER



Built
Especially
for
Stationary
Shop Work

Where the highest
grade of Cement
work is produced
and uniform accu-
racy is required.

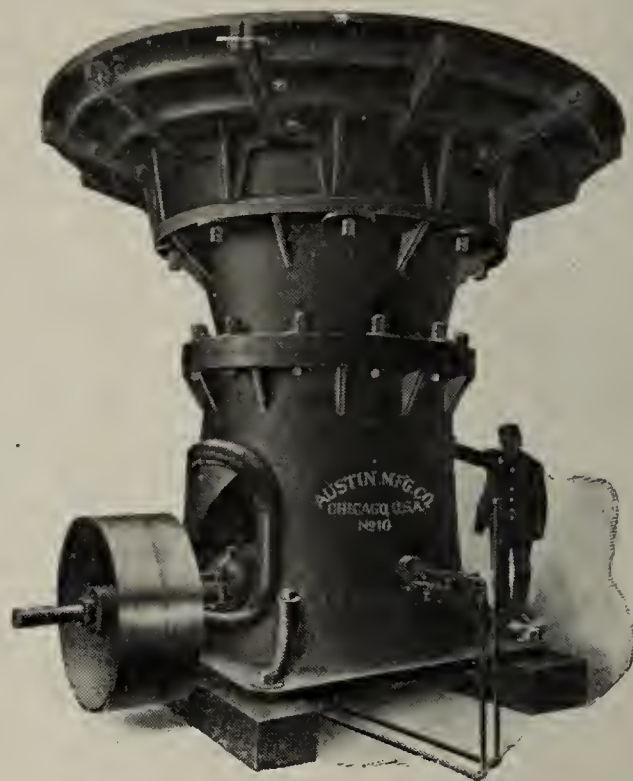
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The World's leading Ore and Rock Crusher. Its many superior qualities and mechanical advantages have won the highest reputation amongst Mining Engineers and Quarrymen.

Made in NINE sizes with capacities from 50 to 5000 tons per day. Smaller sizes can be mounted as Portable Plants. Thousands in use.

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Canadian Agents—Mussens, Ltd., Montreal.
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Diamond Face

Refractory and Acid Proof

Concrete

Portland Cement Carborundum

Stowell Process

U. S. Patent No. 819,467

PAVEMENTS, floors, stair treads or any surface finished with the cement-carborundum composition will never wear out.

It will become so hard it will grind steel or glass.

It will have a fine, live, sparkling surface.

It will be anti-slip and absolutely dustless.

The cost from 2c to 4c the square foot for the ½ in. finish, depending on location and local conditions.

ALSO this composition will make an absolutely fire-proof concrete—a concrete that can be heated to a white heat repeatedly and will not disintegrate; a concrete that will not expand or contract heating or cooling, and one that is not affected by oil or acids; a concrete that can take the place of fireclay products and terra cotta for many purposes and will cost less.

License for the above process granted to reliable cement workers and contractors only. License is let on a very liberal annual rental basis.

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PORTLAND, IND.

SYMENTREX

LIQUID CONCRETE

The Perfect Cement Coating

For Cement Floors, Concrete or Stucco Exteriors, Plastered Interior, Brick and Masonry.

IS WATER RESISTING

is unaffected by alkalis, acids, gases or lubricating oils; because it provides a firm, hard surface when applied to concrete; it is necessarily dust-suppressing and will resist abrasion and scuffing.

Has Powerful Binding Properties

which welds it to and becomes a natural part of the surface.

Dries a Flat, Dull Finish

Varied and attractive color effects are obtained from Symentrex without the artificial appearance of paint.

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which will show you the most desirable of decorative coatings for interior and exterior surfaces, and waterproof at the same time. Get acquainted with it.

George W. De Smet

Distributor of Vulcanite Portland Cement and
Imported French Caen Stone Cement,

419 CHAMBER OF COMMERCE

CHICAGO, ILLINOIS

GUN SHOOTS CONCRETE.

Another device to aid in the overcoming of the obstacles that the engineers of the Panama Canal are encountering has been invented by Col. Goethals. The device is a concrete gun.

The gun shoots a continuous stream of concrete against the rocky sides of the Culebra cut, thus changing a soft stone subject to great erosion in tropical climate to one as hard as granite. Experiments with the gun have proven successful, and have done away with further danger of the sides of the great cut crumbling, which has been the chief trouble in the construction of this portion of the dam.

NEW CONVEYING MACHINERY ORDERED.

The Link Belt Company has secured the contract for all of the conveying machinery for the new edition of the German-American Portland Cement Company's plant at La Salle, Ill. The equipment will consist of elevators, screw conveyors, belt conveyors and other miscellaneous transmission machinery.

This company has also gotten out a new Locomotive Crane, which will be found especially useful around cement mills, for handling clinker, coal, ashes, etc. Special mention has been given to simplicity, so that any ordinary man around the yard can operate it with facility.

**Jeffrey Overlapping Pivoted Bucket Conveyor**

For Handling Cement, Clinker, Stone, Ores, Etc.

Built to discharge at any desired points and requires no mechanical feeding device.

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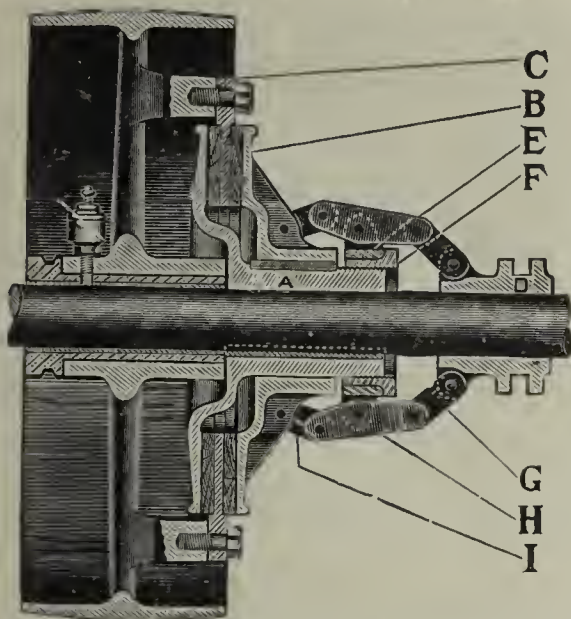
Also Manufacturers of Elevators, Screens, Crushers, Pulverizers, Etc.

Jeffrey Manufacturing Company, Columbus, Ohio

CHICAGO
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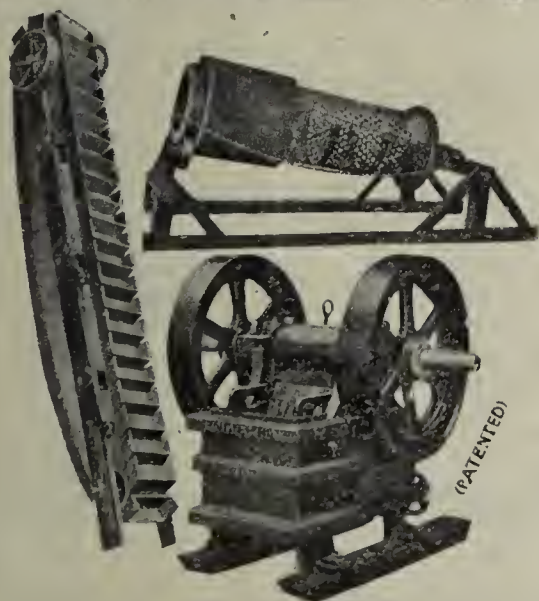
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DISC TYPE FRICTION CLUTCHES
ARE GUARANTEED THE BEST FOR
CEMENT MILL SERVICE

USED AND ENDORSED BY ALL THE LEADING CEMENT MILLS
SIMPLE-POWERFUL-NO SPRINGS OR BOLTS-ONE ADJUSTMENT
ONLY-NOT AFFECTED BY CENTRIFUGAL ACTION OR DUST. LET
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12 TO 24 N. CLINTON ST., CHICAGO, ILL.

**BUY ONE SECOND-HAND**

Try to buy a **VELTEN UNIVERSAL CRUSHER** from one of our customers. One man wrote us he tried it for three months without success. Why? Because Every **UNIVERSAL CRUSHER** is working, giving satisfaction. Because they Crush gravel or any rock to 1", 3/4", 1/2", 1/4" or finer, giving the greatest capacity with the lowest possible power and operating expense. Built to stand the strain and deliver the goods.

OUR PROPOSITION

We will ship to any responsible party on 30 days' trial, without a dollar of payment to us. Write for literature and prices.

UNIVERSAL CRUSHER CO.,

Cedar Rapids, Iowa

BLYSTONE BATCH MIXER



Built
Especially
for
Stationary
Shop Work

Where the highest
grade of Cement
work is produced
and uniform accuracy
is required.

WE CLAIM

To have the Best, Cheapest and most economical shop mixer on the market. It is ready to belt to and can be located at any point in the shop.

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Made in NINE sizes with capacities from 50 to 5000 tons per day. Smaller sizes can be mounted as Portable Plants. Thousands in use.

Plans and specifications furnished for any size of Plant.

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License for the above process granted to reliable cement workers and contractors only. License is let on a very liberal annual rental basis.

For particulars and terms, state territory in which you operate, and address

E. R. STOWELL
PORTLAND, IND.

CANADA PEBBLE CO., LIMITED

Highest Grade
**Grinding
Pebbles**
For Tube Mills

Port Arthur, Canada

PRELIMINARY WORK ON BOX CANYON DAM.

Preliminary work looking to the construction of a dam across Box canyon of the Medina river at a point twenty-six miles north of Dunlay, Texas, has been in progress for about eight months. The company is now constructing a railroad from Dunlay to the site of the dam. This 26-mile line will connect with the Southern Pacific railroad at this place. It will be finished early in July. An army of men are already employed in clearing the land, surveying the lines for the canals and ditches and in other preparatory work. A. W. Billings, of New York, is engineer in charge on the ground.

The dam across Box canyon will be 160 feet high. It will be of stone and reinforced concrete construction. It is estimated that the cost of equipment that will be necessary for the construction of the dam will be more than \$200,000. Two cableways will be strung across the canyon. They will be capable of depositing 10-ton stones and loads of smaller stone and concrete to any part of the dam. Ten large derricks will supplement this equipment. Running down the sides of the canyon will be two incline railways for delivering material. A rock crushing plant, capable of producing 200 tons of crushed stone per hour and a large crushing plant for the purpose of making artificial sand will be installed. A concrete mixing plant with a capacity of 150 cubic yards of concrete per hour will also be placed at the dam site. The machinery for the different plants and equipment will be operated by a steam power plant. A temporary electric light plant for affording light for the construction camp and for carrying on night labor at the dam will also be installed. It is estimated that 200,000 barrels of cement will be required for the works.

Preparations are being made for opening up a large rock quarry near the site of the dam. The company will equip this quarry with two locomotive cranes for loading the 10-ton blocks of stone onto cars. In some places the canals will have to be carried long distances through concrete flumes.

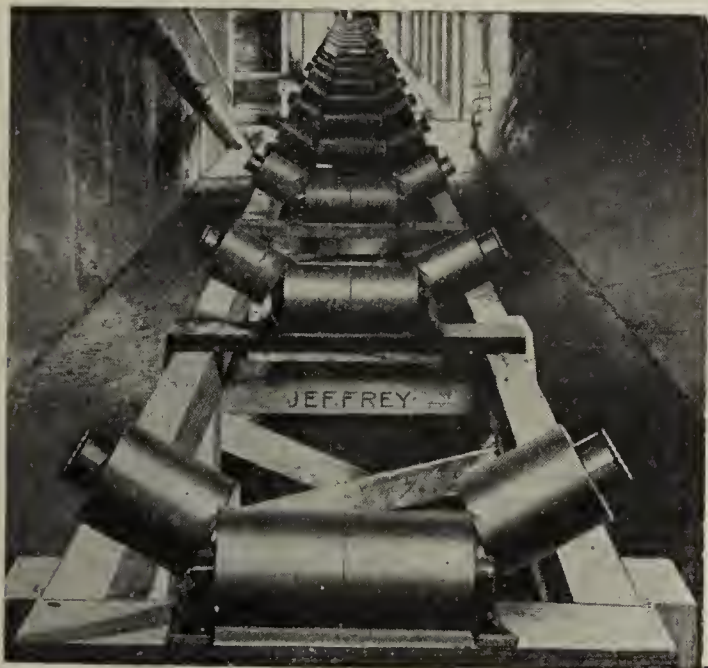
The main dam will be supplemented by a diversion dam, four miles below. This second dam will be sixty feet high and 800 feet wide. The main reservoir will cover a surface of 5,000 acres.

The company expects to develop a large amount of electric power which will be transmitted to San Antonio and other towns, but this feature of the enterprise is as yet in a formative stage.

TESTING LABORATORY FOR UNIVERSITY OF TEXAS.

In order to comply with numerous requests for information concerning cement rocks, clay, coal, etc., a new testing laboratory has been added to the resources of the Bureau of Economic Geology and Technology of the University of Texas, Dr. William B. Phillips, director. It is the purpose of the bureau and laboratory to aid the citizens of the state in the development and use of the mineral resources within its borders.

The Piedmont Portland Cement Company is a corporation authorized under the laws of Georgia with a paid in capital of \$400,000.00. The officers of the Company are: J. C. Bass, Pres.; Wade H. Davis, Sec. & Treas.; J. G. Stipe, Ass't Sec.; Wm. S. Davis, Supt.

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for handling Coal, Coke, Ore, Stone, etc., give the greatest efficiency at minimum cost for installation and upkeep

Designers and Builders of Elevators, Conveyers, Power Transmission Machinery, Screens, Crushers, Pulverizers, etc., for use in cement working industries.

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Try to buy a VELTEN UNIVERSAL CRUSHER from one of our customers. One man wrote us he tried it for three months without success. Why? Because Every UNIVERSAL CRUSHER is working, giving satisfaction. Because they Crush gravel or any rock to 1", 3/4", 1/2", 1/4" or finer, giving the greatest capacity with the lowest possible power and operating expense. Built to stand the strain and deliver the goods.

OUR PROPOSITION

We will ship to any responsible party on 30 days' trial, without a dollar of payment to us. Write for literature and prices.

UNIVERSAL CRUSHER CO.,

Cedar Rapids, Iowa



BLYSTONE BATCH MIXER



Built
Especially
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Stationary
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Where the highest
grade of Cement
work is produced
and uniform accu-
racy is required.

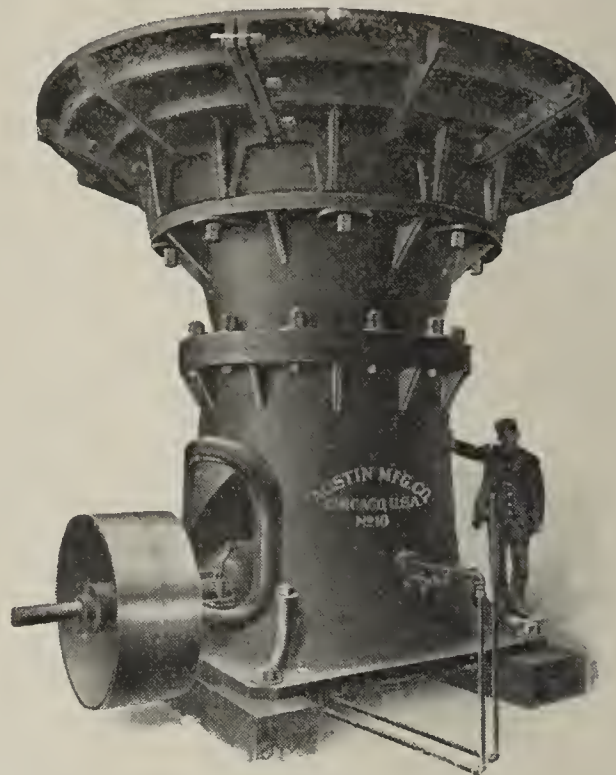
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All styles—all sizes—for all kinds of materials

Estimates given to suit any requirements.
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Highest Grade
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STRUCTURAL ENGINEERING.

Structural Engineering is the title of a comprehensive book by J. Husband and W. Harby, in which the authors have endeavored to deal with the design of the more ordinary and commonly occurring structures from a theoretical and practical point of view.

The consideration of column strength has been treated more fully than is customary in works on structural engineering.

A brief section is devoted to tall building construction.

A special chapter contains a summary of the properties of structural materials.

The information contained in this work will prove to be of general utility to both draftsmen and students.

Price, \$2.60. Cement & Engineering News will forward the book upon receipt of price.

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken for less than two dollars and must be paid strictly in advance.

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Cement salesman by a cement company located in the middle West. State experience, with what companies, and salary expected. Whether married or single. Address L. K., Cement & Engineering News, 1117 Schiller Bldg., Chicago.

POSITION WANTED.

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It does not attempt to cover the constantly changing details of reinforced concrete construction, but devotes itself to analysis and design. To make these more readily comprehensible several designs of reinforced concrete structures are worked out in detail with particular reference to the proper sequence of computation. The principles of economy in design are set forth, and the diagrams in use lead to the proper selection of steel and concrete dimensions.

This book simplifies the methods of analysis and design in reinforced concrete. It is a concise treatise that is admirably adapted to the needs of engineers and students. Price..... \$2.00

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BRASS STRAIGHTWAY OR Y
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The improved construction of the disc prevents dirt or scale from lodging on the seat and a tight valve is insured.

The seat bearings can be reground and all parts subjected to wear can be renewed.

The valves are made in sizes ranging from $\frac{3}{4}$ to 2½ inches inclusive.

Your local dealer can furnish them. If not, write us.

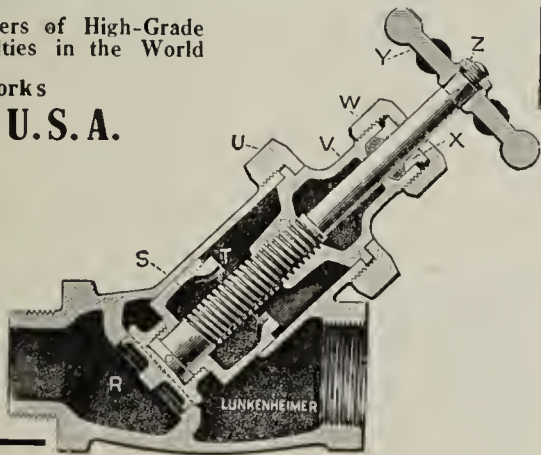
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For handling Stone, Ore, etc., are built to meet every demand of the severest working conditions, with minimum cost for installation and upkeep.

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Bucket
Elevator

At large stone quarry; 95 ft. high; capacity 750 tons per hour; carries crushed stone from crusher to revolving screens.

Designers and builders of Elevators and Conveyers of various types for handling stone, ore, cement, etc. Also complete line of Power Transmission Machinery. Send for latest catalogs describing our various lines.

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BLYSTONE BATCH MIXER



Built
Especially
for
Stationary
Shop Work

Where the highest
grade of Cement
work is produced
and uniform accur-
acy is required.

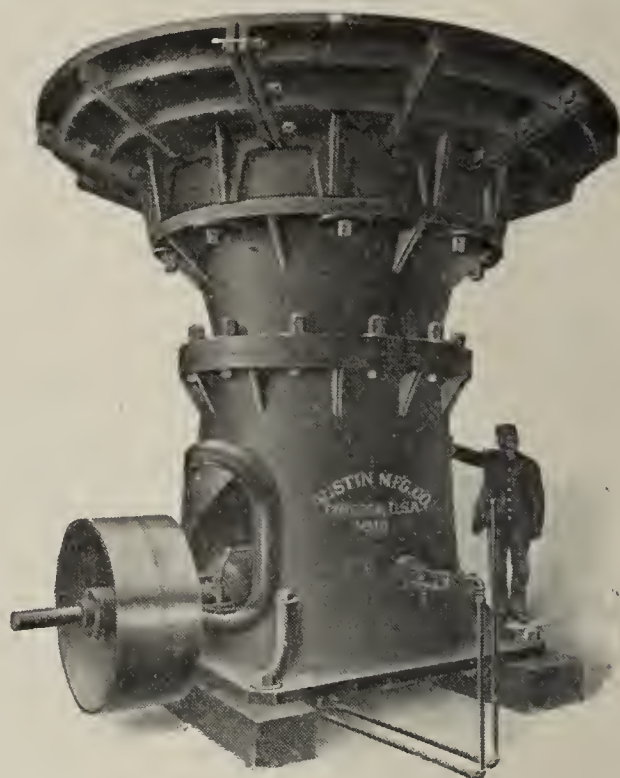
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Revolving, Shaker or
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All styles—all sizes—for all kinds of materials

Estimates given to suit any requirements.
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CANADA PEBBLE CO., LIMITED

Highest Grade
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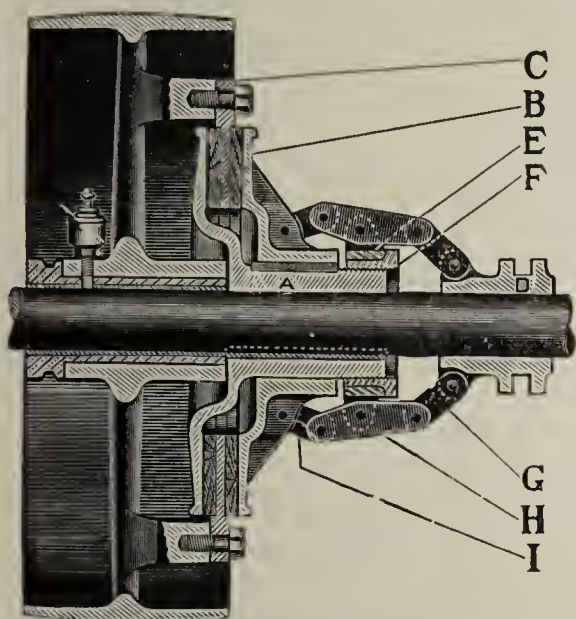
Many years' experience proves the **DIVISION METHOD** (patented) the only Economical, Efficient and Reliable, as well as the most Scientifically and Mechanically Perfect Process for the manufacture of high-grade **SILICA BRICK AND STONE**—the **Twentieth Century Building Material**.

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USED AND ENDORSED BY ALL THE LEADING CEMENT MILLS
SIMPLE—POWERFUL—NO SPRINGS OR BOLTS—ONE ADJUSTMENT
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THE AMERICAN CLAY MACHINERY CO.

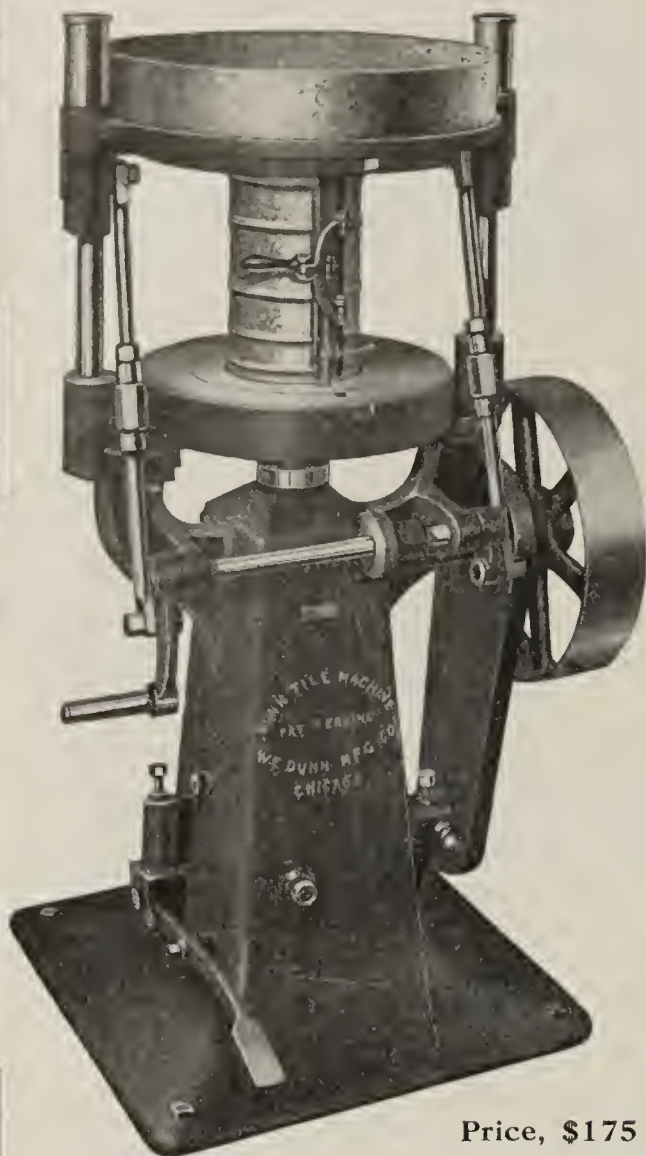
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It is built from the ground up. There are no bolts to work loose and no shaft can get out of line. All working parts are enclosed in the heavy cast iron base, perfectly protected from dust and sand. Even the chain is protected by a solid guard.

Packs the tile hard at the bottom, making them of equal density at both ends, and every tile perfect.

Table of machine 34 inches high. Just the right height for operator.

We ship the machine on 15 days, free trial and if it isn't satisfactory or won't do all we claim for it, then ship it back. That's a safe way for you to buy. We'll take the chances of the machine making good because we know what it will do.

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It tells all about this tile machine, besides, block machines, brick machines, porch and chimney molds. Send today while you think of it.

W. E. DUNN MFG. CO. ⁴¹³⁹ **FILLMORE STREET CHICAGO**

CEMENT PLANTS EVERYWHERE USE **ADVANCE PUMPS**



A TEXAS SCENE—BIG RESULTS ALWAYS

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Power
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THE BEST FOR HIGH CLASS ENGINEERING WORK

High Tensile
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The Recognized Standard American Brand

Quality Unexcelled Always Uniform
Annual Output 6,500,000 Barrels

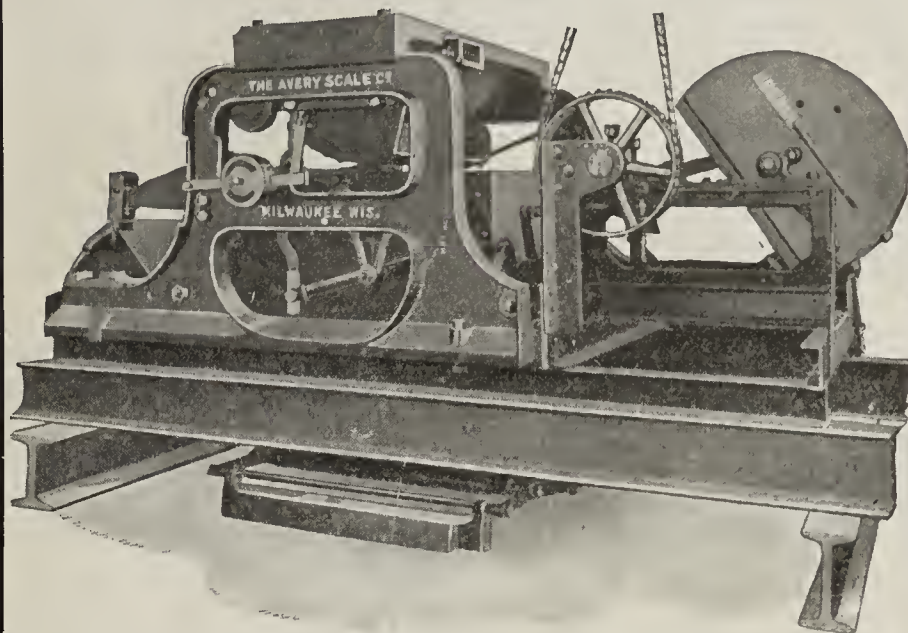
Alpha Portland Cement Company

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Chicago Office
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Works at Alpha, N. J., Martins Creek, Pa.,
Manheim, W. Va., and Alsens, N. Y.

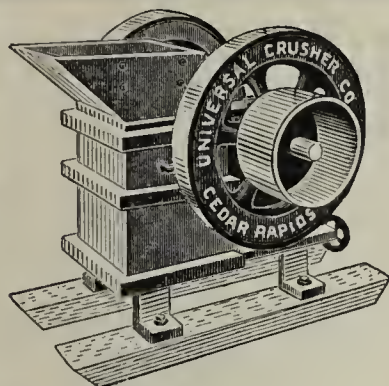
THE AVERY AUTOMATIC CLINKER SCALE WITH GYPSUM MEASURER



This machine will automatically weigh the clinker coming from the kilns, and also add the desired percentage of gypsum. Every cement manufacturer knows the importance of having a record of the amount of clinker which he uses, and also is fully aware of the importance of having the correct quantity of gypsum added to the clinker in order to enable him to turn out the desired grade of cement.

The above machine automatically weighs a fixed quantity of clinker each discharge and the measurer delivers a certain percentage of gypsum according to the manner it has been adjusted. The gypsum measurer is usually arranged so that it can deliver from one to five per cent of the clinker as the manufacturer desires. For full particulars and quotations write.

The Avery Scale Company, North Milwaukee, Wis.



No. 2 UNIVERSAL

A profit maker for the concrete contractor.

A guaranteed high standard machine at the lowest price.

THE UNIVERSAL CRUSHER

IS INSTANTLY ADJUSTABLE to crush to any size. Reduces rock to **sand** in one operation.

MAKES A UNIFORM PRODUCT in every size without screening. **JAWS OF MANGANESE STEEL**, all moving parts of crucible steel, hand-forged hammered steel shaft. Bearings equipped with interchangeable bronze shells—they never run hot.

CRUSHES gravel or any rock to any desired fineness—uses a minimum of power, simple and easy to install, never breaks down. All sizes. 30 days' trial. **Our Guarantee Can Be Depended On.**

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By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

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These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

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No concrete man, no matter how small his jobs, can afford to be without one. The men can not slight the work or get away from any part of it, as each one has his part to do. I can easily put down 2500 sq. ft. of sidewalk in ten hours with 8 men.

Have used my mixer one year and a half without any expense. Would not think of doing without "THE BOLTE."

Yours very truly,
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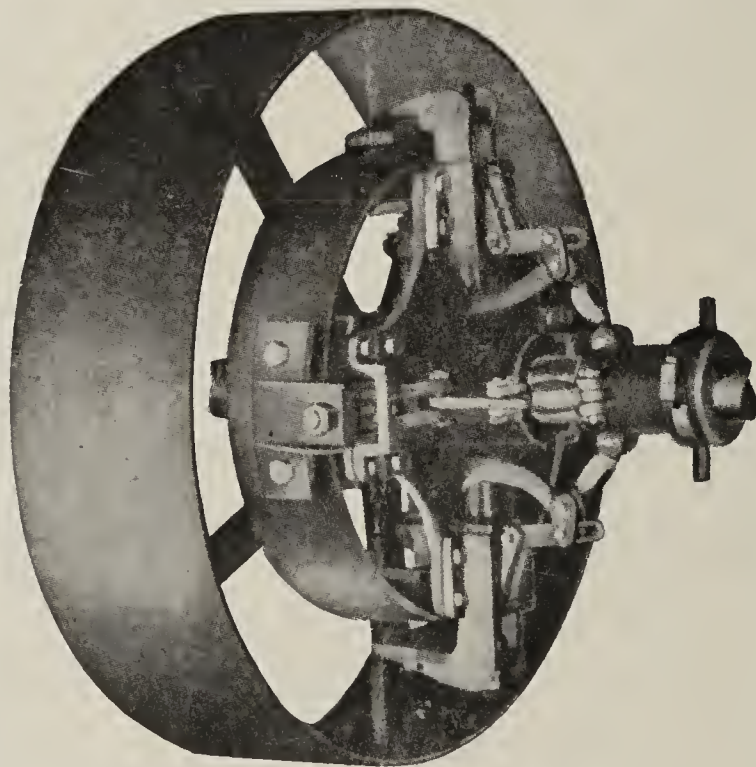
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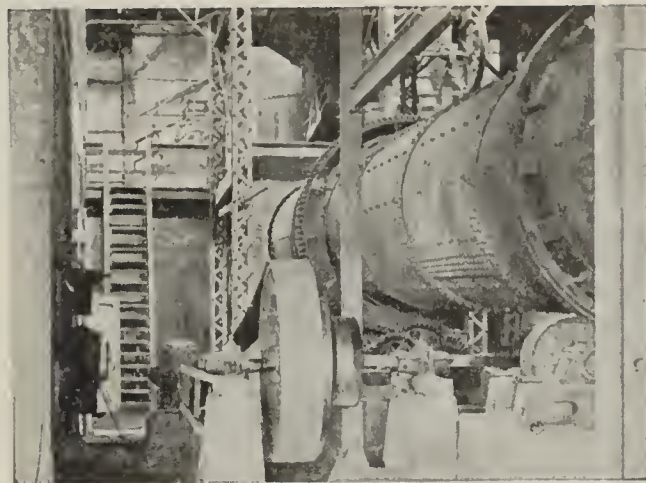
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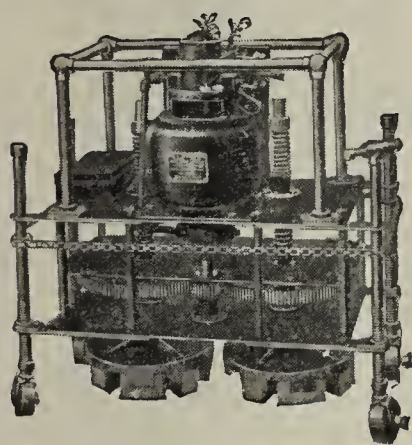
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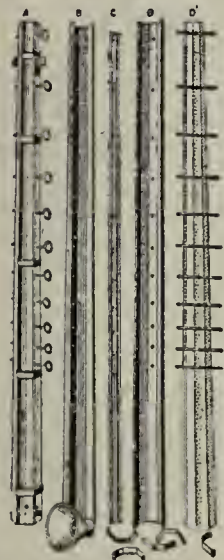
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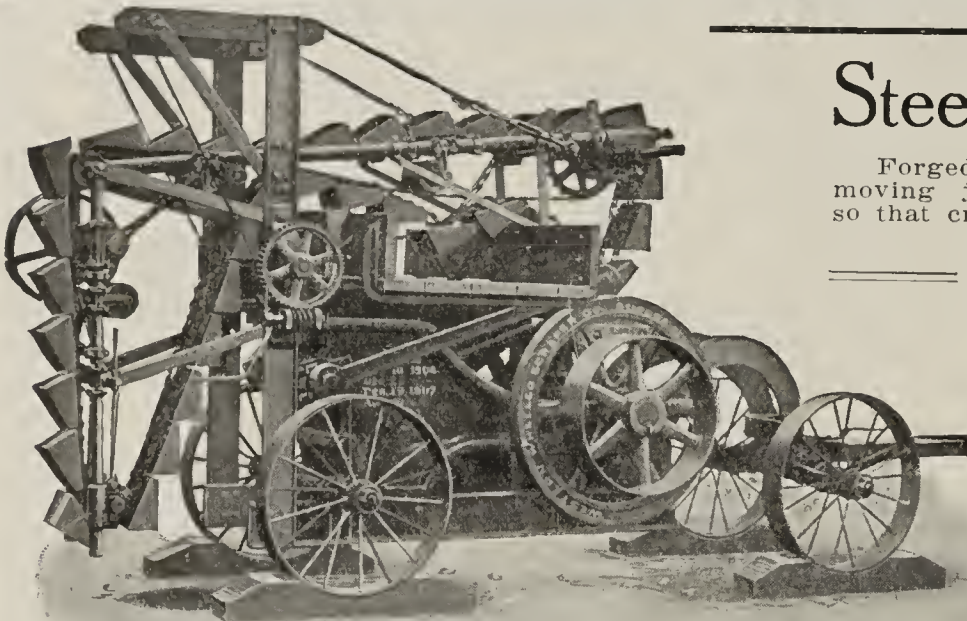
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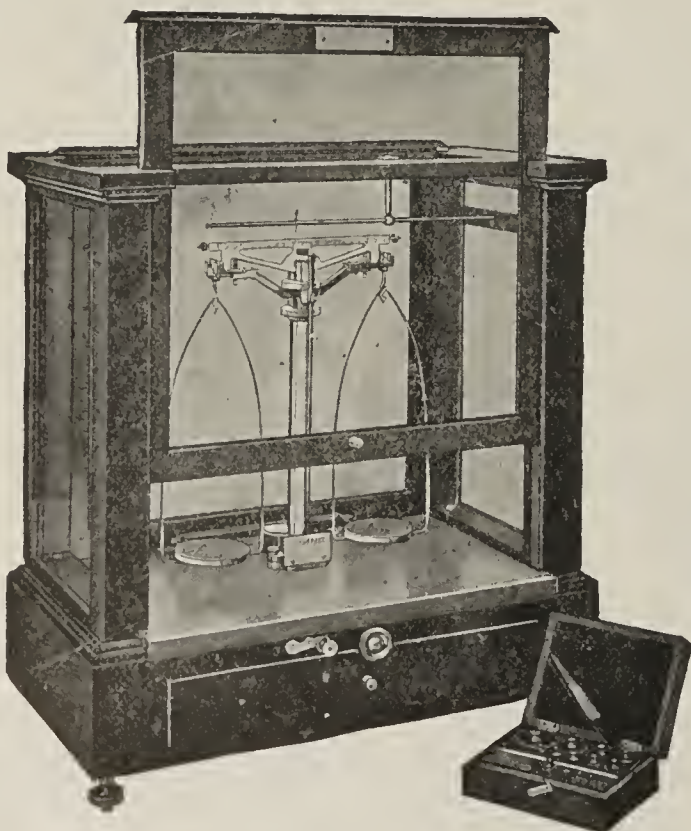
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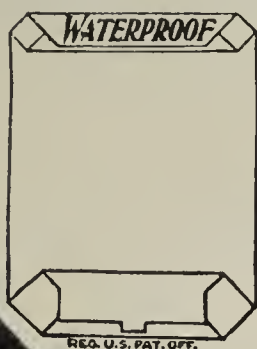
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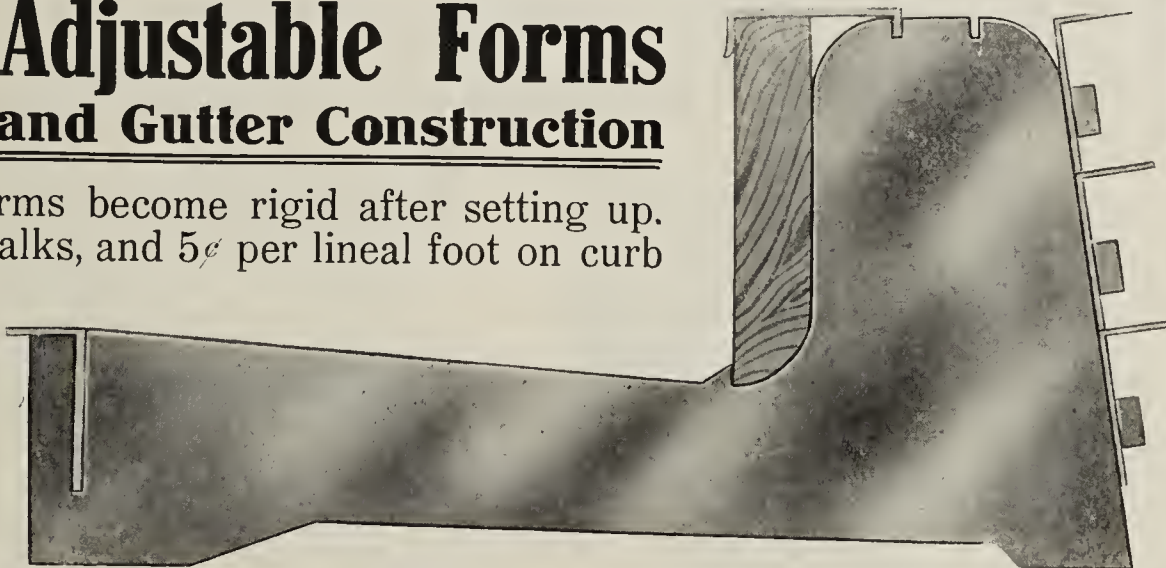
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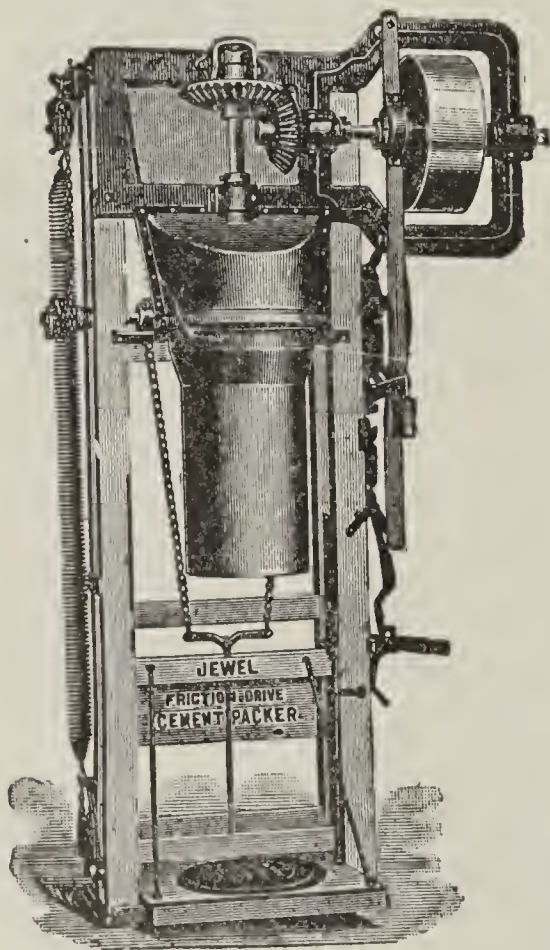


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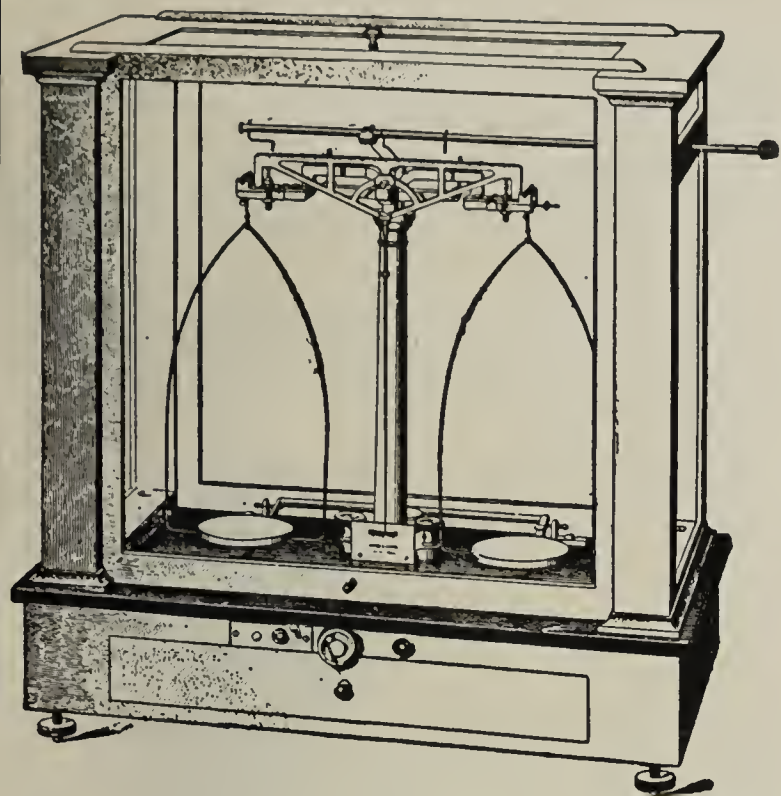
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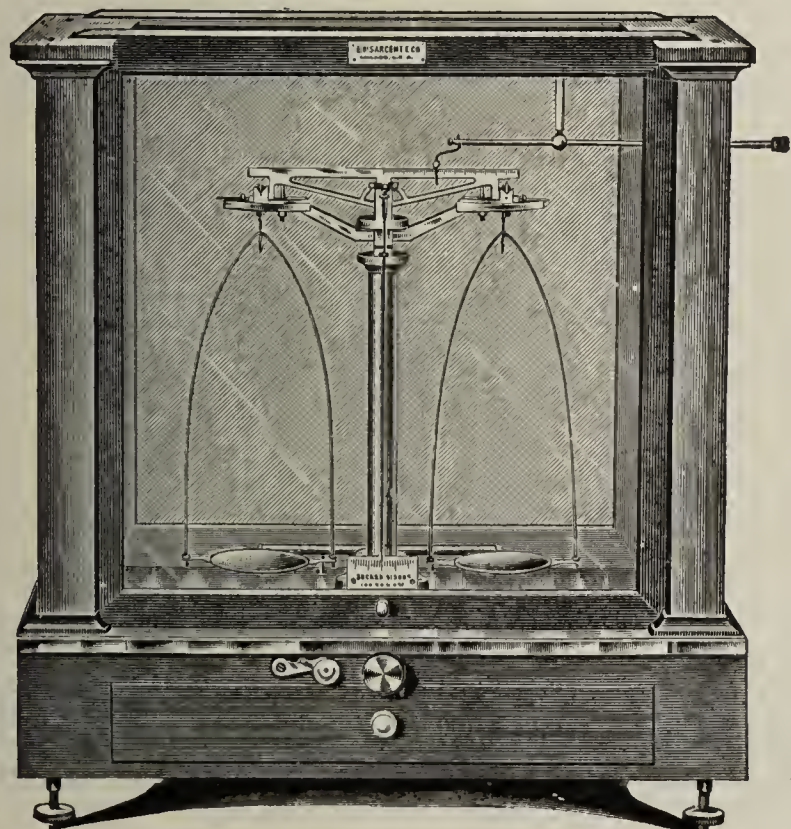
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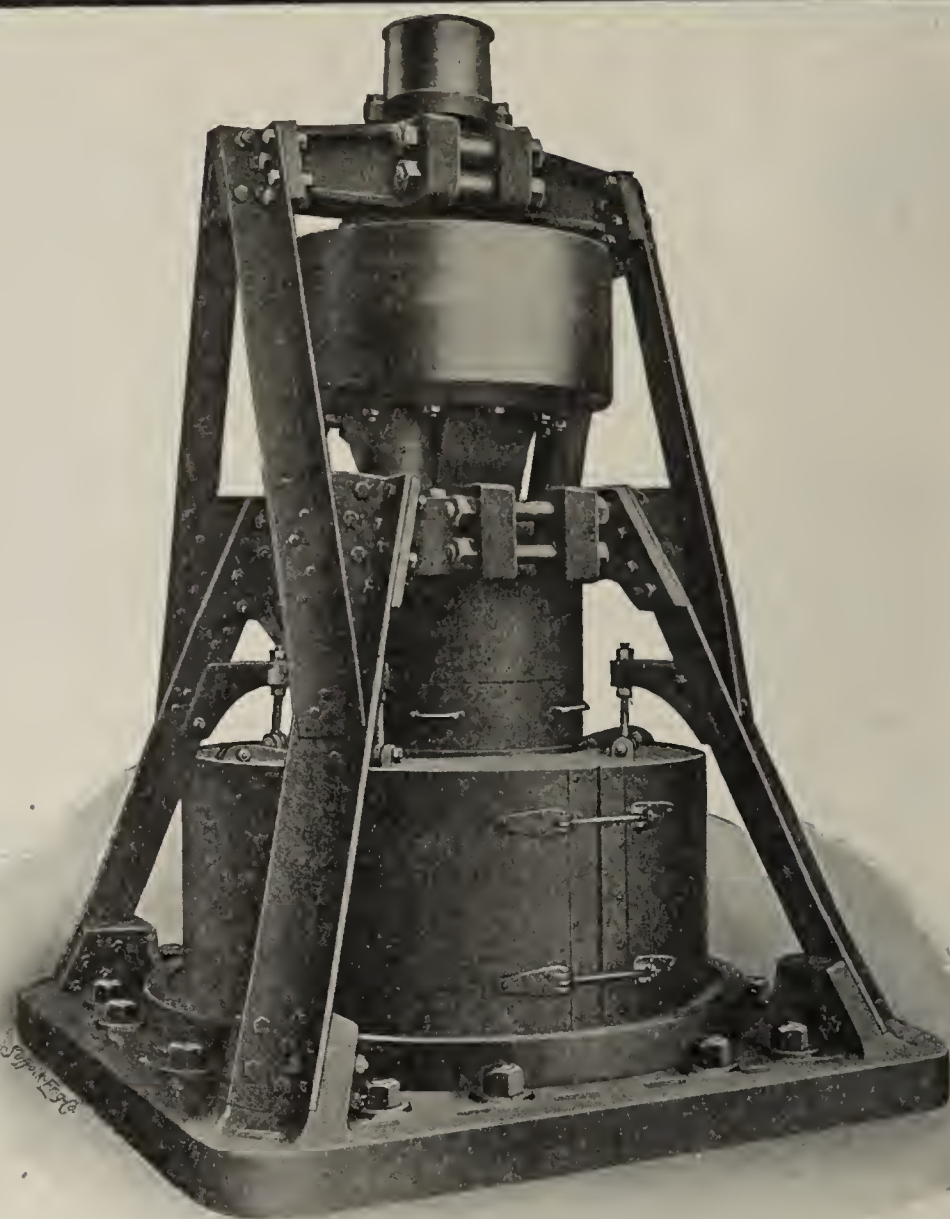
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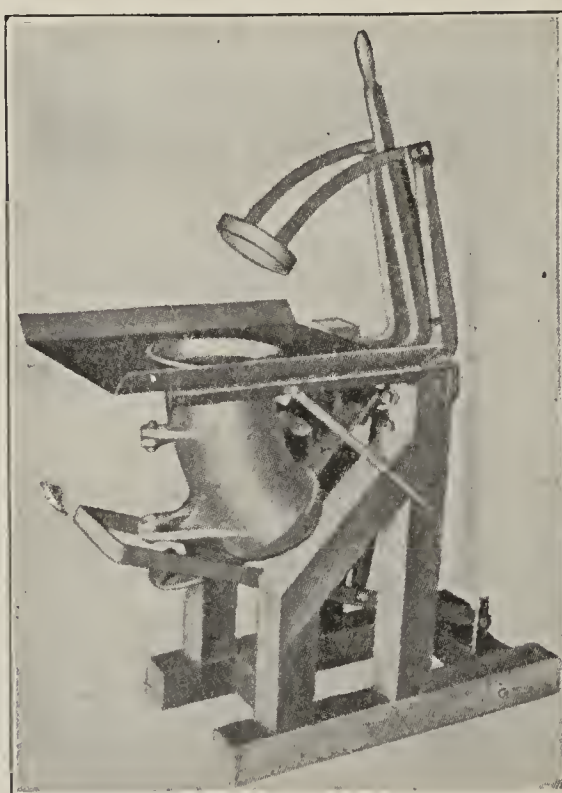
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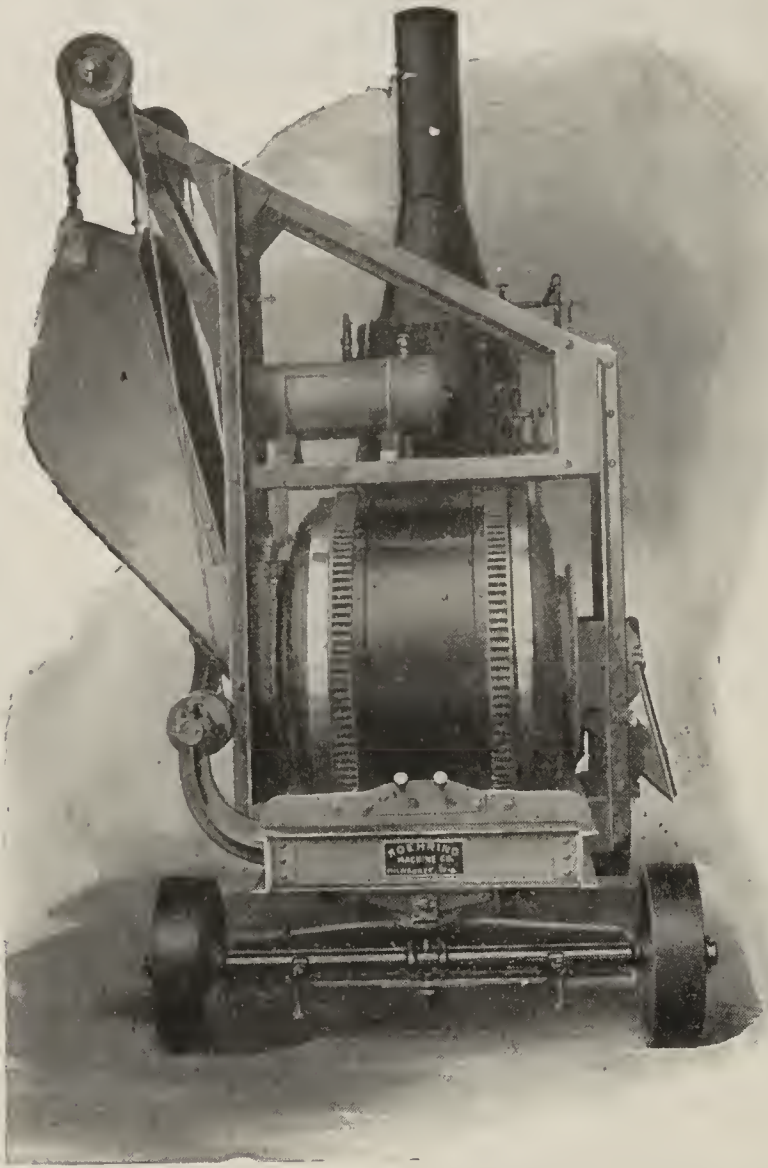
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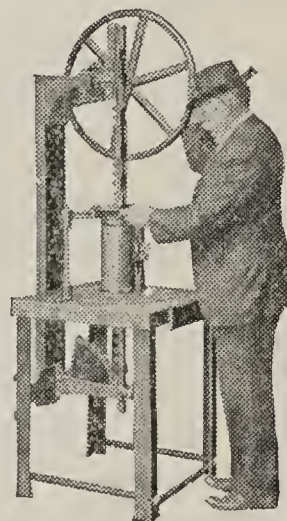
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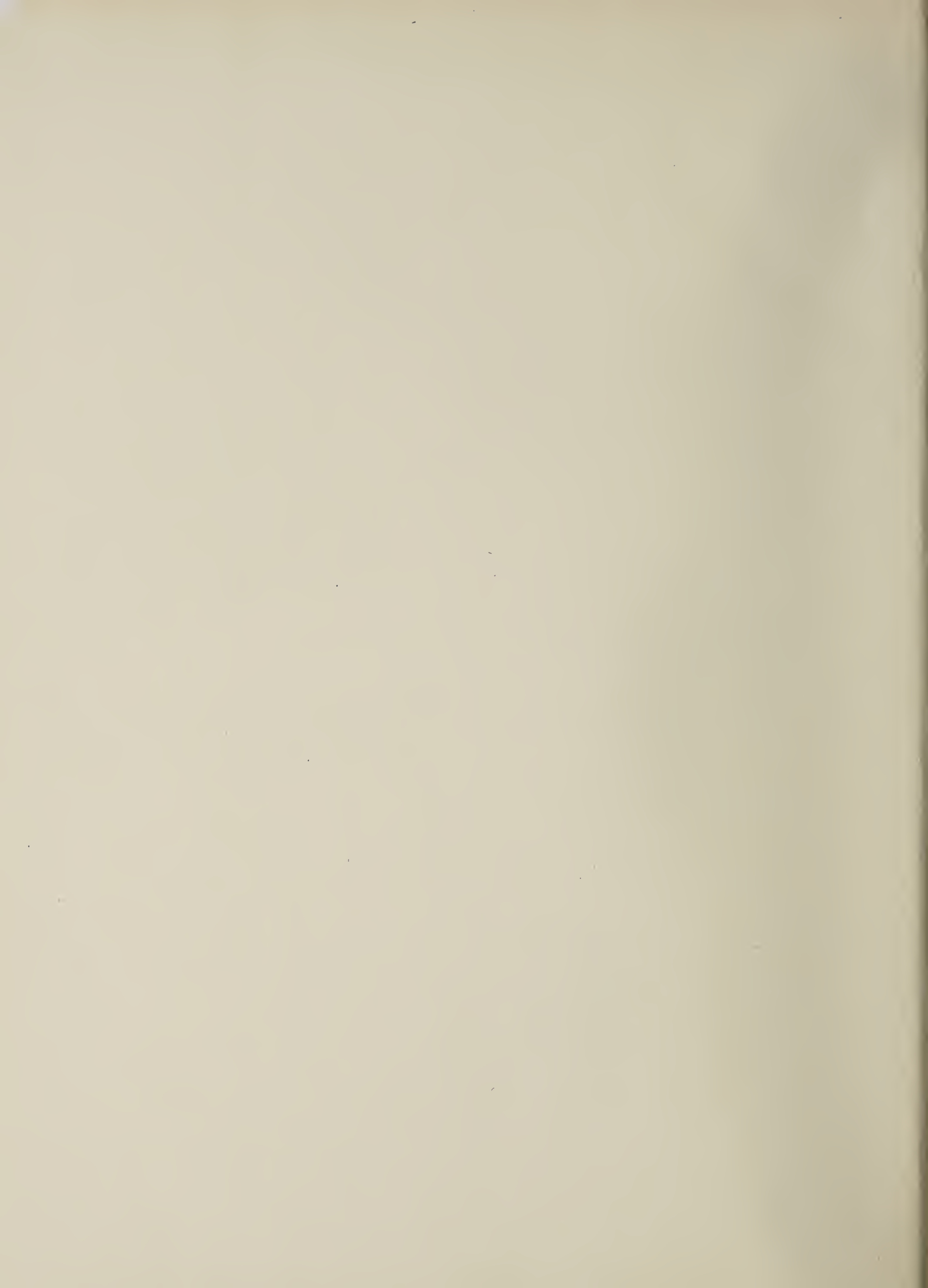
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